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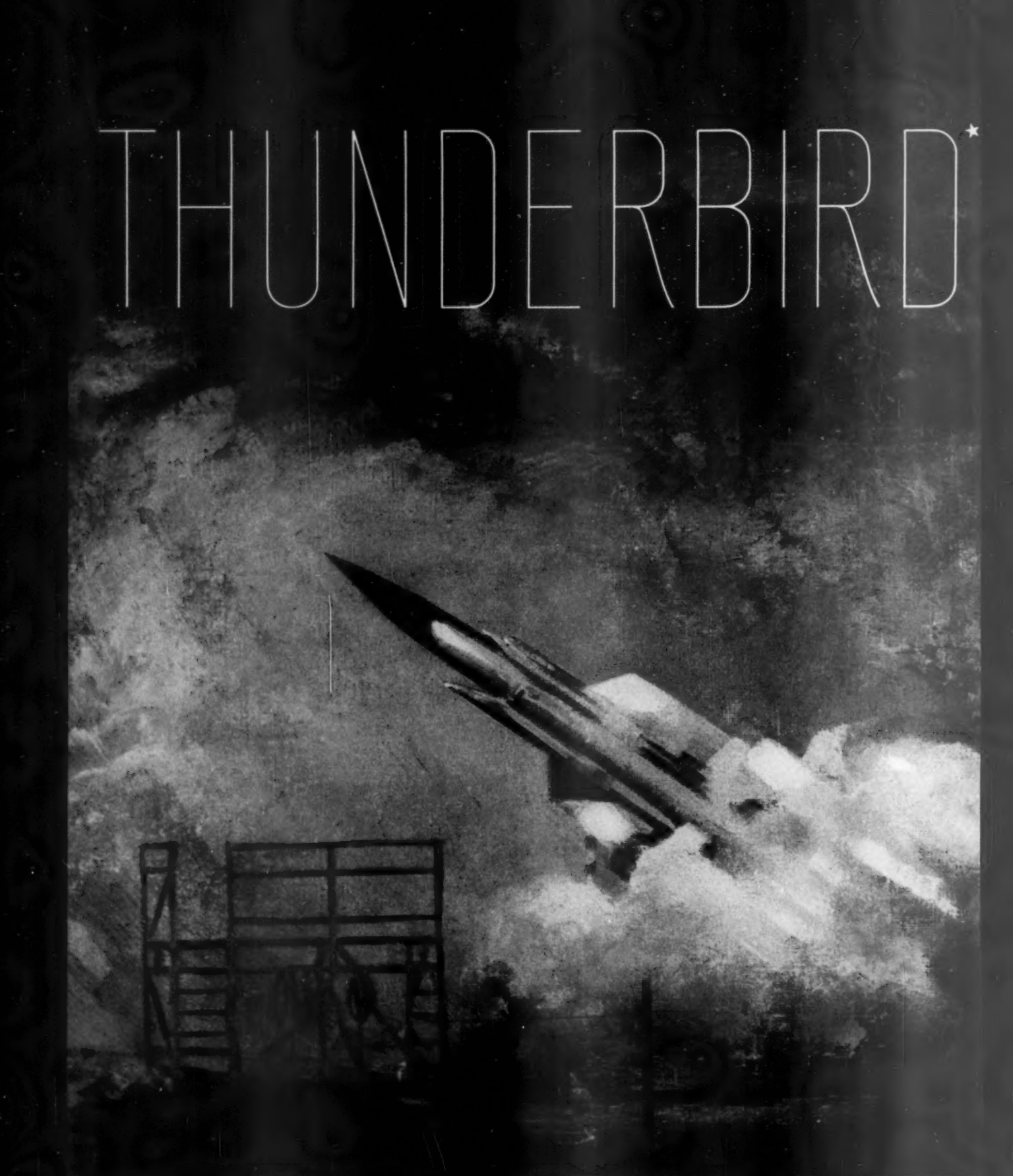

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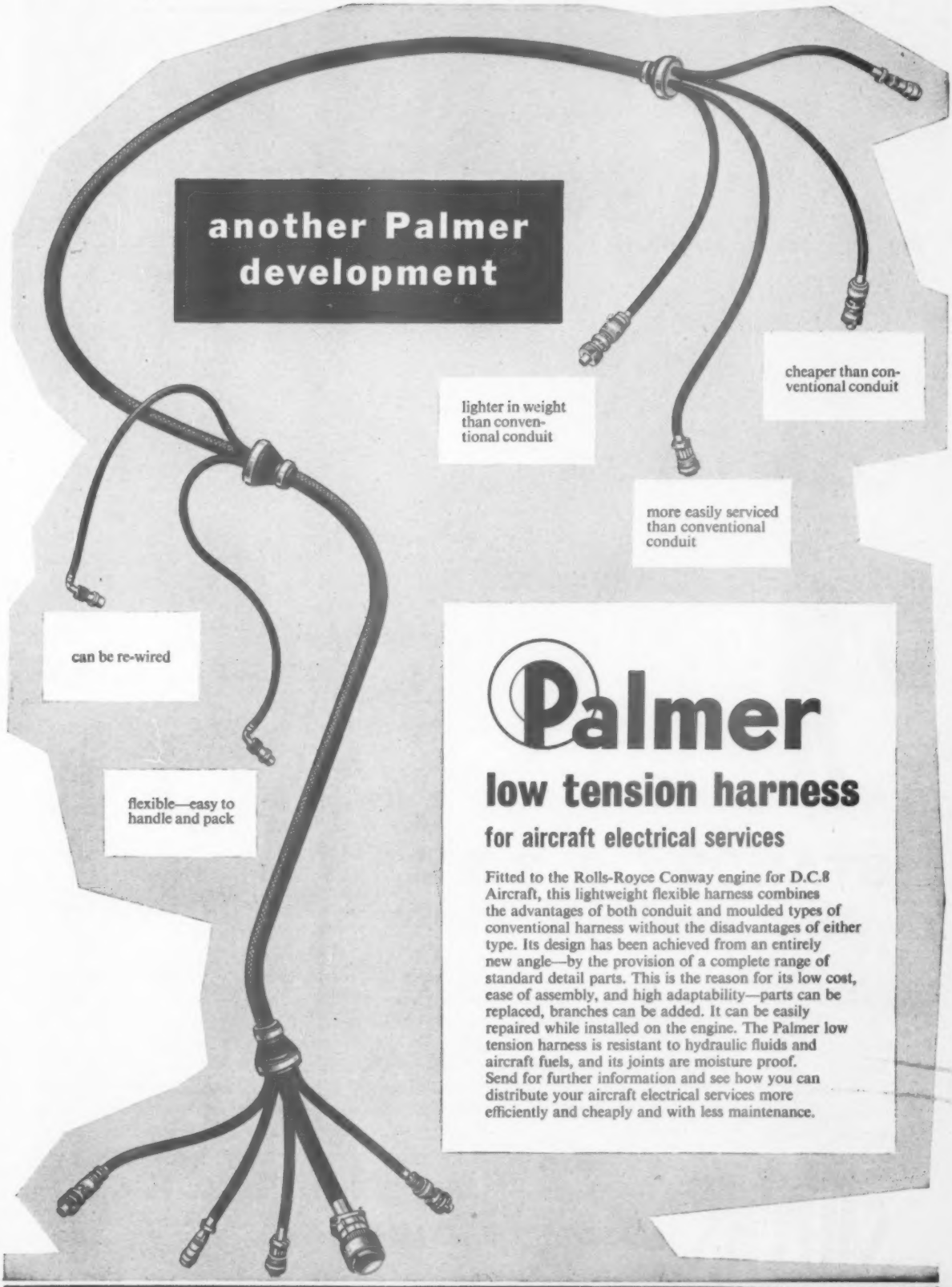

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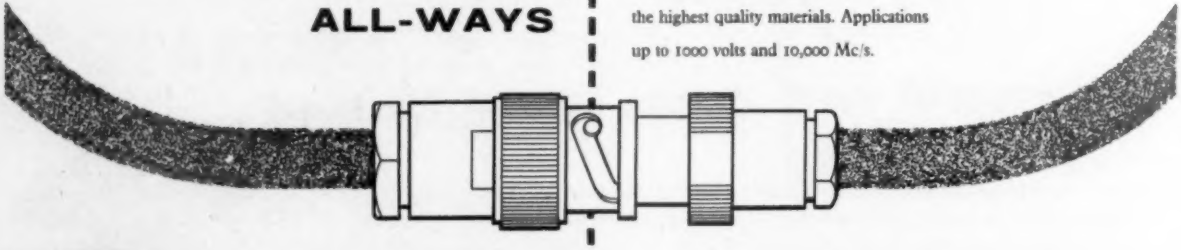

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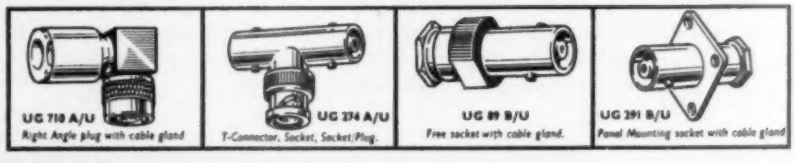
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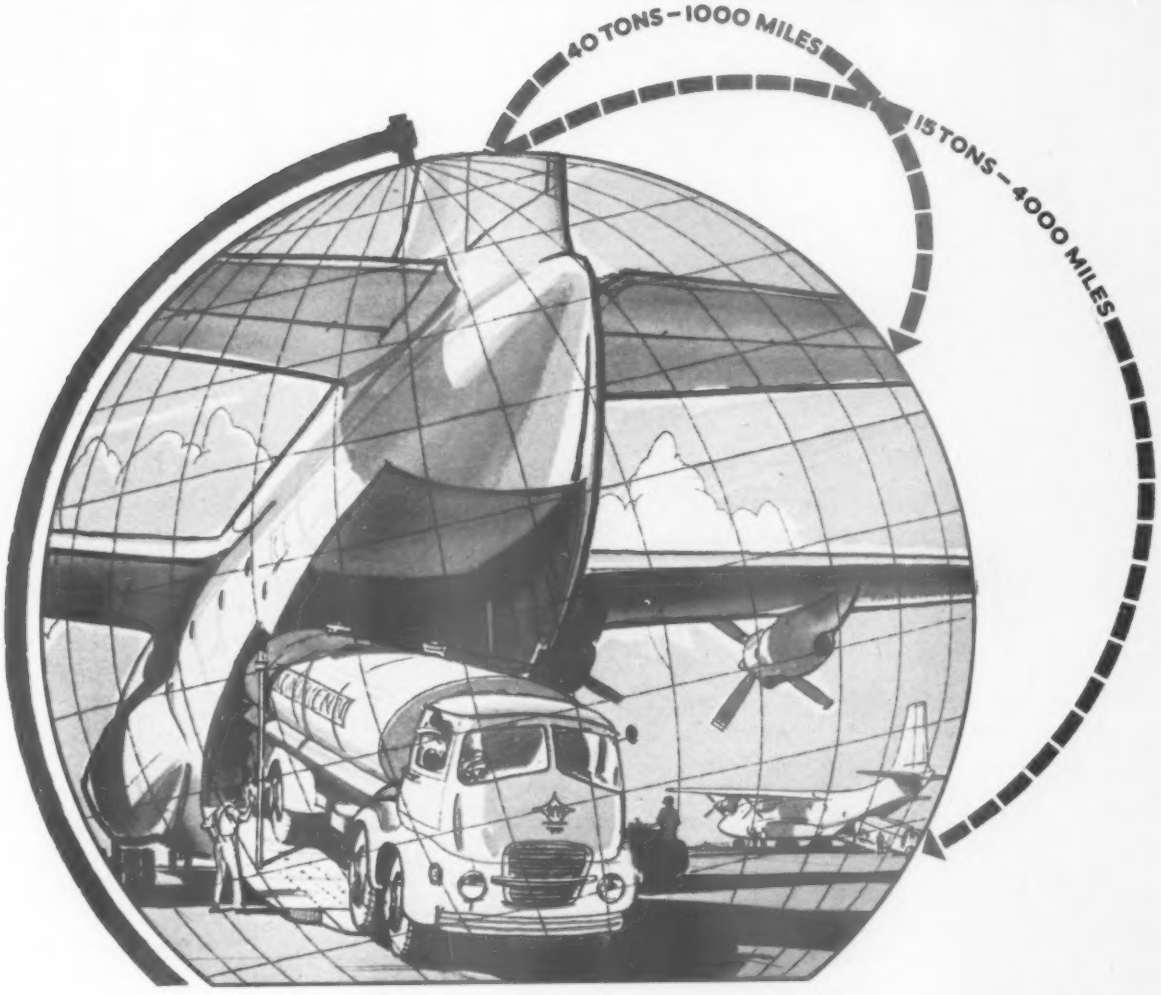

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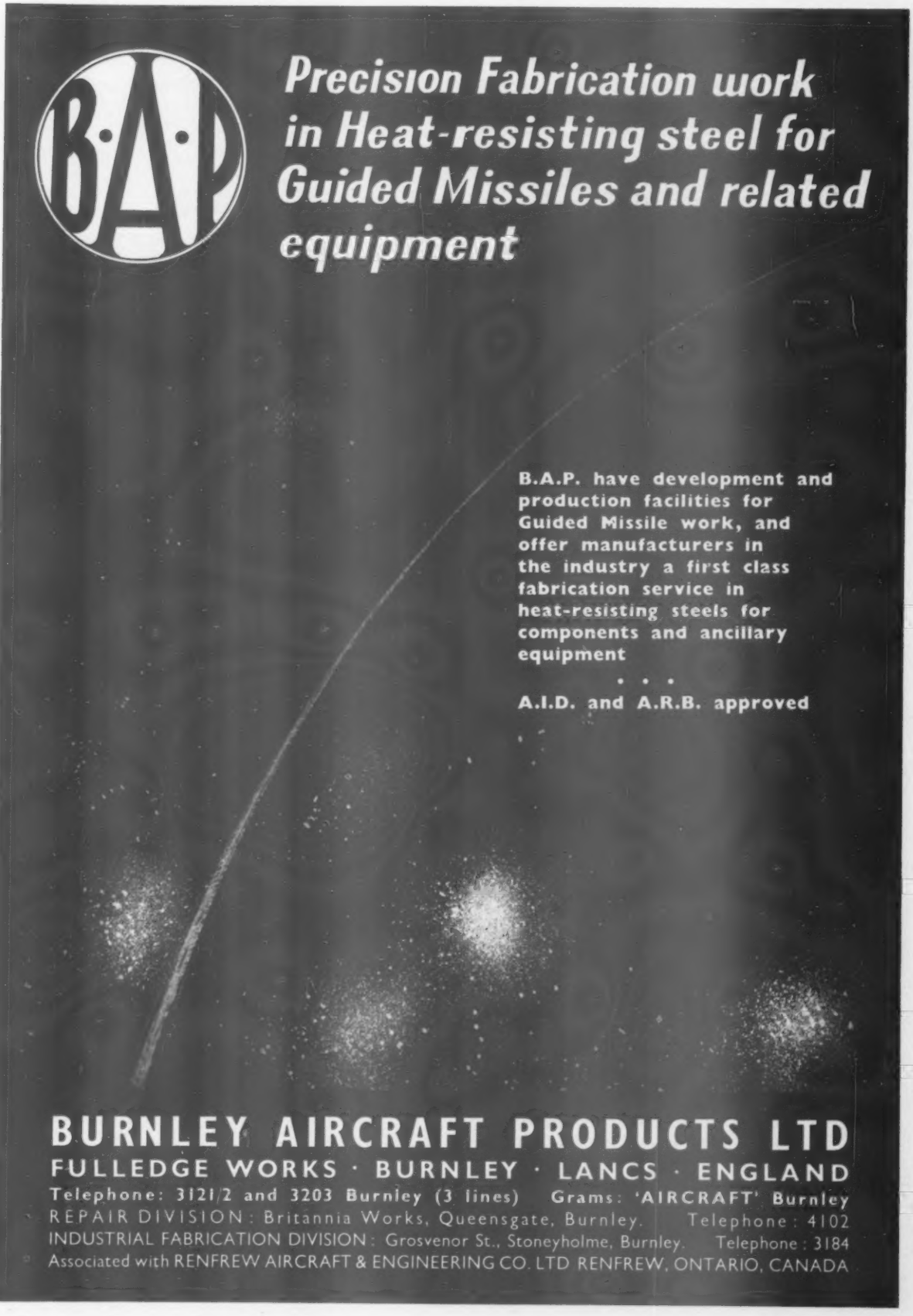
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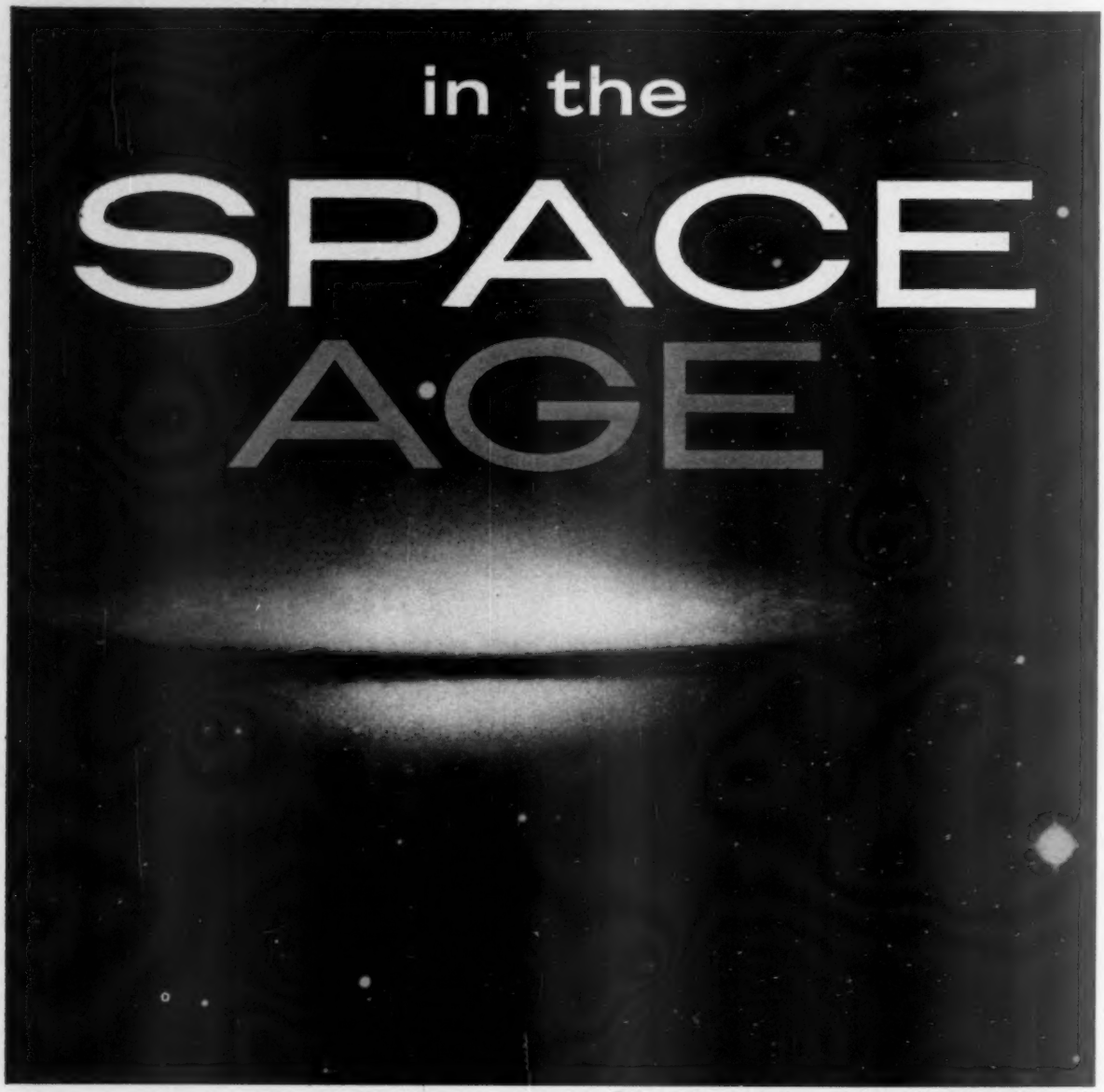

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THE AEROPLANE and ASTRONAUTICS

VOLUME 97 NUMBER 2497 AUGUST 28, 1959

Out into Space

On Thursday, August 27, there is to open at Church House, Westminster, the first of two conferences which, though they have been hardly heralded in the daily Press, are likely, in their eventual impact, to change both Government policy and public awareness. The first of these is the Commonwealth Spaceflight Symposium; the second is the tenth Congress of the International Astronautical Federation. And to the aims and intentions of the organizers a substantial portion of this issue of our paper is devoted.

There is no longer need to argue the case for the practicability of exploring space. Day after day, man-launched vehicles, swinging round in orbit, radio back to their launchers information from far beyond our atmosphere. Soon these robot exploring devices will be followed by satellites of wider practical benefit, for example, by those providing for improved communications and meteorological information. What the organizers of the Commonwealth Symposium hope to do, and we earnestly hope they will succeed, is to concert means whereby the Commonwealth may take an active part in such activities and not solely as guests using loaned equipment. It was our own British Interplanetary Society which first put forward plans for a "minimum" satellite in 1951. It is the same pioneer group which has organized these conferences.

An article by the I.A.F. president in our supplement shows that the I.A.F. is motivated by the belief that excursions into space must be made on an international, and not by each nation on an individual, basis. In its ten years of existence the I.A.F. has worked for international collaboration and one has only to look at the lecture list to see how much has been achieved in this direction.

Degrees in Demand

Redundancy among aircraft workers is very much in the news at the present time, as well as the strikes which have come about as a result. At the same time the advertisement columns show that many companies are simultaneously seeking technical staff. To take only two examples, Hawker Siddeley Aviation wants design and research engineers of almost every type, while English Electric is casting a similar wide net. These companies are not alone; others are also in the market for technicians.

How can this apparent paradox be explained? In some cases the companies may be setting their sights on a supersonic-transport order. Certainly this is a sheet-anchor prospect, but the Industry will face a cold future when decisions on the supersonic airliner have been made. Rationalization must follow, regardless of the decision made.

The Aircraft Industry has always had a relatively higher percentage of technical personnel than other industries. Clearly this will rise even higher in future as aircraft and missiles of greater performance and complexity are produced, though in smaller quantities than in the past.

Design man-hours for aircraft have risen steadily over the years, but this alone does not seem likely to account fully for the present demand for technical men. The answer may lie in the urgency of current projects. The development times planned for typical projects such as the D.H. 121 and the TSR-2 are much shorter than for comparable aircraft in the past. Tight schedules for complex new aircraft demand

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large-scale technical resources. Greater concentrations of technical personnel are essential.

Short development times are now the vogue; for civil aircraft they are essential if overseas competition is to be withstood. But speedy development of aircraft can bring other economic benefits to manufacturers, for overhead costs are directly related to development times. This in itself can be a spur to rapid development.

As already indicated, technical people are in considerable demand. Could this be because many have left the industry, doubtful about its future? Some have done so, but it is significant that membership of the Royal Aeronautical Society, the professional body for aeronautical engineers, has continued to rise.

One feature of the recent advertisements is disappointing—rarely have companies asked for production engineers. In the past the Industry has been criticized more for its production record than for the quality of its designs and, according to the Minister of Supply, "rationalization has had no other objective than the creation of units which can produce fast." Delivery dates have rarely been sacrosanct and this has had a bad effect on airliner sales.

A better balance is needed between the technical resources devoted to production and those to design. The production side has often played a Cinderella rôle, particularly in its recruitment of graduate engineers; this could prove fatal in future.

Matters of Moment

Civilian Controller

SIR GEORGE GARDNER, K.B.E., C.B., D.Sc., M.I.Mech.E., F.R.Ae.S., has been appointed Controller of Aircraft at the Ministry of Supply in succession to Air Chief Marshal Sir Claude Pelly, who has been appointed Member (Designate) for Weapons of the Atomic Energy Authority. Sir George, who has been Director of the Royal Aircraft Establishment, Farnborough, since November, 1955, is the first civilian to become Controller of Aircraft; the post has been held since its inception during the 1939-45 War by senior R.A.F. officers.

Born in 1903, Sir George was educated at Campbell College and Queen's University, Belfast, and was with Harland and Wolff, Ltd., between 1919 and 1925. He joined the R.A.E. in 1926, becoming head of the Instrument and Photographic Department in 1943 and head of the Controlled Weapons Department in 1945. In 1947 he was appointed Director, Guided Weapons (R. and D.) and in 1951 Principal Director, Guided Weapons. Between 1953 and 1955 he was Director-General of Technical Development (Air) at the Ministry of Supply.

So far back as 1927 Sir George, then a junior at the R.A.E., was working on Larynx, which could have been the British flying bomb. He had a narrow escape during an abortive launch, being knocked over head first onto a steel deck—perhaps the first casualty of such a weapon.

Canadian Starfighters

IN our last issue we recorded the selection of the Lockheed F-104G Starfighter to re-equip the Canadair Sabre 6 day fighter squadrons of the R.C.A.F. NATO Air Division in Europe. The Canadian Government has now announced production details, following the completion of negotiations with Lockheed and General Electric, covering manufacture of the aircraft and its engine under licence in Canada.

Canadair, Ltd., has been selected to build the airframe after competitive proposals had been received from Canada's three major aircraft manufacturers (Avro Aircraft, Ltd., The de Havilland Aircraft of Canada, Ltd., and Canadair) and Orenda Engines, Ltd., is to produce the J79 axial-flow turbojet. The manufacture of the airframe constitutes approximately 36% of the total programme and the powerplant production 31%, so that a reasonable regional distribution (Montreal and Ontario) of the industrial effort involved has been achieved.

The Canadian Government is to enter into a contract on the basis of the Canadair offer to produce the 200 airframes required at a ceiling cost of $91.5 million, excluding variable costs under Government control and based on the present Starfighter specifications. If the actual cost is less than the ceiling price the saving is to be shared on the basis of one-third to the company and two-thirds to the Government.

The contract to Orenda Engines will be on a similar basis. Arrangements for the fire-control system and other elements of the programme have not yet been completed.

New M.o.S. Chief Scientist

DR. ROBERT COCKBURN, C.B., O.B.E., M.Sc., has been appointed chief scientist of the Ministry of Supply; he succeeds Sir Owen Wansbrough-Jones who is resigning from the Civil Service on September 30. Since October, 1956, Dr. Cockburn has been controller of guided weapons and electronics at the M.o.S.

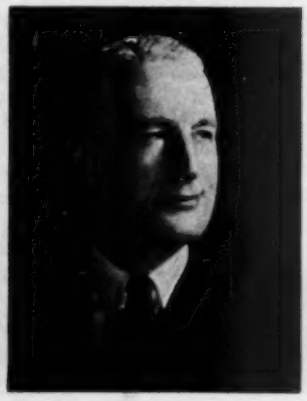
Born in 1909, he was educated at London University and between 1928 and 1937 taught physics at Portsmouth and West Ham Municipal Colleges. He then joined the R.A.E. radio department for two years. In 1939 he went to the T.R.E. as head of the radio counter-measures division, becoming the superintendent of T.R.E. in 1944.

Between 1945 and 1948 he worked on reactor research at the Chalk River atomic-energy research establishment and at Harwell. He was appointed scientific adviser to the Air Ministry in 1948. In 1953 he went to the Ministry of Supply as principal director of scientific research (guided weapons and electronics).

Agriculture at Cranfield

THE International Agricultural Aviation Conference which is being held at the College of Aeronautics, Cranfield, from September 14-19, is being organized under the auspices of the O.E.E.C., and will attract visitors and speakers from all over the World. Its primary concern, however, will be agricultural operations in Europe, and it will be opened by Sir Miles Thomas.

Towards the end of the meeting, on Friday, September 18, some 17 fixed- and rotary-wing agricultural aircraft will take part in a large-scale demonstration of spraying and top-dressing operations, together with the appliances and chemicals used. Several of the aircraft will be on show for the first time in Great Britain, notably the Czech L.60 Brigadyr, the Piper PA-25 Pawnee, and the Brantly B-2 helicopter. Other types will include the D.H.C.2 Beaver, various modified Tiger Moths, the



MEN IN NEWS.—Left, Dr. Robert Cockburn, he is to be chief scientist at the M.o.S. Middle, Mr. E. C. Wheeldon, new deputy chairman of Saunders-Roe. Right, Mr. D. C. Collins, appointed Westland deputy managing director.

AGRICULTURAL VISITOR.—The new Piper PA-25 Pawnee, being produced at the rate of one per day in the U.S. will feature in the flight demonstrations of crop spraying aircraft at Cranfield on September 18.

L.A.C. E.P.9 Prospector, the Auster Agricola, Workmaster and J.1B Aiglet, the Piper P.A.-18A, the Bell 47G, the Hiller UH-12B and the Djinn.

Official delegates will see these aircraft demonstrated in the morning, and in the afternoon, from 14.30 hrs., the flying programme will be repeated for visiting farmers and members of the public. The aircraft will be open to inspection from 12.00 hrs. onwards, and there will also be a static show.

Vertol 107

A RECENT rotary-wing visitor that has been attracting much favourable comment during its tour of airfields and Service establishments is the tandem-rotor Vertol 107. It is the prototype of the new YHC-1 for the U.S. Army. With an all-up weight of 17,000 lb. and a total of 2,000 s.h.p. the Vertol 107 is half the weight of the Fairey Rotodyne and Westland Westminster. It is to be available for sale in Europe at the end of 1960 and is offered for sale without engines at £175,000. It can carry a payload of 5,764 lb. at 129 knots for 100 miles, unload it, reload, then return at the same speed and land with a fuel reserve of 10% of the initial fuel load. The 856-cu.-ft. freight hold has rear ramp loading.

The two General Electric T58-6 turbines, each of 1,050 s.h.p. are mounted side by side over the aft end of the fuselage and feed into a common mixing-box. From gear-boxes drive-shafts run directly to the forward rotor and to the rear rotor over the engines. By virtue of this arrangement, should either engine have to be shut down, power is available for both rotors without switching. Owing to restrictions placed by the U.S. Army on the prototype it has not been possible to demonstrate single-engine performance.

An observation that has been often heard about the tandem rotor arrangement is that it makes for vibration in the air. During a recent trip of 10 minutes in the visiting machine from the Battersea heliport, we were impressed by the absence of vibration over a range of speeds from take-off to 200 km./hr. (124 m.p.h.).

The Vertol 107 had been brought in by Mr. Jock Cameron of B.E.A. in the left-hand seat accompanied by Mr. Philip Camerano of Vertols in the right-hand seat from which the machine is normally flown. There was a five-knot easterly wind. One was impressed by the smooth way in which the machine was brought down on to the landing circle. It was the same during the demonstration flights. On each occasion the Vertol 107 was climbed smoothly away on a level keel. Forward tilt, so noticeable as the single-rotor helicopter changes attitude for forward speed, was apparently absent.

During the course of the brief demonstration at Battersea the 107 was put down in the river. The rear sponsons which contain the fuel tanks together with the watertight hull provide buoyancy and stability. The machine appears very much at home in this amphibious guise and its manœuvrability is such that a small Sargasso sea of driftwood and floating debris appeared to embarrass the pilot not a bit. For such immersions the undercarriage is not retractable.

During the demonstration the machine was flying at 16,000 lb. The freight cabin had been partitioned off to contain seven seats in a sound-proofed compartment and in here at all speeds from 60 km./hr. on the climb to 200 km./hr. the noise level was low. Conversation was uninhibited and the attention of other passengers could be attracted by calling to them across the space—which is not always the case.

A proposition which is being discussed should the Canadian Service authorities place an order for the machine would be for the airframe to be built by a Canadian constructor. In this country and in Canada the T58-6 engines are built under licence by de Havilland as the Gnome.

One can also see that such a machine with so much experience behind it (some 1,100 Vertol tandem-rotor helicopters have been built) is likely to prove attractive to those in B.E.A. interested in pushing on with helicopter development, for it will not be until 1963 that the Fairey Rotodyne is to be in service with Tyne engines.

RIVERBORNE.—The Vertol 107 taxiing on the Thames off the Battersea Heliport.

Science Museum Appeal

EXTENSIONS are being made to the Science Museum at South Kensington and it is hoped that almost all the National Aeronautical Collection can be exhibited by the end of 1960. The Museum is asking the Aircraft Industry to give financial assistance for this reorganization and to lend or donate items for exhibition. At least £30,000 is needed if the aeronautical exhibits are to be displayed to a standard comparable with others in the Museum. The Government contribution includes the new building and furniture, costing in all nearly £200,000.

Canberra Escape Aids

EXTENSIVE modifications, it was recently revealed, have been made to the design of the Canberra P.R.9 by Short Brothers and Harland, who are responsible for its production at Belfast. The alterations were principally concerned with the provision of an ejection seat for the navigator, who in the Canberra B.(I)8 and early P.R.9, with a similar crew layout, did not have this escape aid.

When the decision was taken to install an automatic ejection

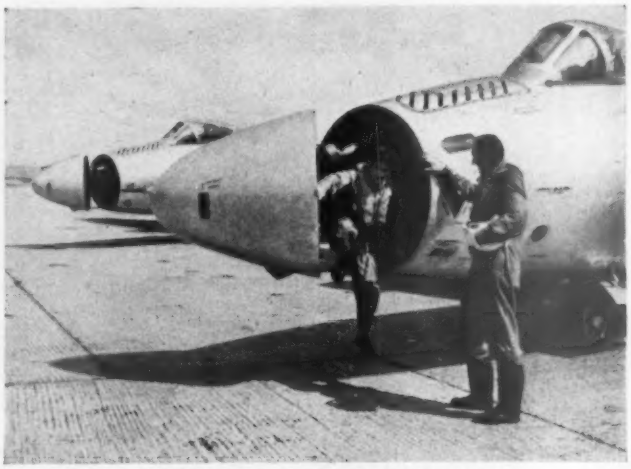
seat in production P.R.9 aircraft, a complete redesign of the nose section, and redistribution of all navigational and photographic control equipment became necessary. In the original P.R.9, the navigator was seated on a swivel chair mounted on rails, for rapid access to the various instruments distributed throughout the nose. A separate strengthened seat was provided against the rear cabin bulkhead as a crash position, and a section of floor aft of the transparent nose was upholstered for lying prone when sighting during photography.

An ejection seat had necessarily to be fixed, however, and it became essential to group all instruments, including those for camera sighting and control within easy reach. This reduced the useful cabin volume by about half, within which a completely unobstructed ejection path had to be provided, in addition to accommodating a number of new instruments.

In less than two months, a mock-up of the redesigned nose was completed by the Experimental Department at Queen's Island. In the revised layout, all photographic controls were concentrated to port, with the main navigational equipment positioned immediately forward of the operator, together with a tail-warning indicator. Subsidiary navigation instruments, oxygen regulator, intercom. controls and lighting switches were mounted to starboard.

To replace the nose sighting position, the navigator was provided with a periscopic sight, and a hinged chart table resting on his knees automatically folds clear for ejection. The slightly modified Martin-Baker Mk. 4 automatic ejection seat is fired through a specially designed glass-fibre penetrable hatch above the nose. Frangible hatches were first explored in earlier Canberras by Martin-Bakers, and that in the P.R.9 can be partly opened for an emergency landing.

As the original entrance door and windbreak for the navigator could not be used, the entire nose of the Canberra, with much of its equipment, had to be hinged for ground entry and egress, with consequent structural and pressurization problems. The cabin floor had also to be lowered for additional room while the original nose windows were eliminated and others provided. All these modifications were accomplished without altering the overall dimensions of the aircraft, with only minor changes of C.G., and no structural changes aft of the original navigator's position.



ESCAPE CHANGE.—As a result of fitting Martin-Baker ejection seats for the navigator, the Canberra P.R.9 now has a hinged nose.

The Founder of Hendon

CLAUDE GRAHAME-WHITE, once hero of every boy in the country, died of heart trouble in hospital in Nice on August 19 after a three weeks' illness. He would have been 80 on August 21. At his last public appearance in London for the Handley Page jubilee celebrations he was in good health and spirits. Yet, except for a few members of the Royal Aero Club, he was no longer remembered and many, on reading of his death, were surprised to learn of his great age. This was because his business success had been outside the realms of flying in which he had made his name. And the aerodrome which he provided for London became famous under its own name of Hendon, and not as the home of the Grahame-White School of Flying.

With his elder brother Montague he started in the motor car business in 1896 and in 1909 turned to flying, learning at the Blériot school at Issy-les-Moulineaux, now the Paris heliport. The year before Aviators' Certificates were issued in the U.K. he qualified for one from the Aero Club de France and was the first certificated British pilot. His own account of the event will be found in THE AEROPLANE for December 18, 1953. In this he tells how the first time he ever left the ground he was accompanied by a passenger who knew even less about flying than he did!

Then he founded a British flying school at Pau and later went to the Farman school to learn biplane technique, with his eye on the *Daily Mail* London to Manchester £10,000 prize. Farman's test pilot Louis Paulhan also had his eye on the prize but, as Claude bought a Farman, Henri Farman promised him a week's grace.

It is history how Claude started from Park Royal in April, 1910, but was beaten by the weather; started again a week later from Wormwood Scrubs and was beaten by Paulhan. The *Daily Mail* had offered a little-remembered £1,000 for the greatest aggregate distance flown in England or France from August 15, 1909 to August 14, 1910. There again Claude, with 842 miles, came second to Paulhan with 855 miles.

Paulhan had started for Manchester from a field at Hendon and when Claude brought his flying school from Pau to Brooklands he inspected this field for an aerodrome. He found the land was leased to a firm called the London Aerodrome Co., Ltd. run by a Mr. Arnham.

In 1910 he went to the United States to represent the R.Ae.C. in the annual closed circuit speed race for the Gordon Bennett challenge cup and won at just under 60 m.p.h. Thereafter he entered for many races and prizes in the U.S.A. and picked up enough prize money to bring the purchase of Hendon within his reach. He was invited to visit Mr. Taft, then President of the United States, and arrived by air, landing in a street in Washington near the White House in his Farman.

Grahame-White moved from Brooklands to Hendon on January 1, 1911 as a tenant, formed Grahame-White, Blériot and Maxim Ltd., to take over the lease from Arnham. This firm was soon replaced by Grahame-White Aviation Ltd., which bought the freehold for £20,000. Hangars, plant, restaurants and public enclosures were erected and it became a popular rendezvous with flying meetings every week-end attracting crowds of over 50,000. It was as organizer here that the late Richard Gates made his name.

Spectacular races were organized under Royal Aero Club rules and when a Belgian pilot (resident in France), Brindejonc des Moulinais, was suspended by the Club for flying his Blériot over London en route from France to Hendon to compete, Grahame-White resigned from the Club and the breach wasn't healed till 1948.

Under Claude's management many famous pilots flew at Hendon including Hamel, Hucks, Vedrines, Beaumont, Cody, Hawker, Alcock and others; and the Aerial Derbys and other famous races were held there. After the Kaiser's War he tried to revive pylon racing but speeds were too high by then to be safe. The first R.A.F. Display (called Pageant the first year) was staged there in 1922 drawing crowds of over 100,000 annually till 1937.

At the outbreak of the Kaiser's War he joined the R.N.A.S. and took part in a seaplane raid on Cuxhaven but was forced down by engine trouble and rescued. And thereafter he devoted his energy to manufacturing aircraft for the Services and operating a flying school for the R.N.A.S.

In his heyday Claude Grahame-White was a hero to all teenage boys with a spirit of adventure. There was none like him. He had a pleasant singing voice which delighted informal aeronautical gatherings.

Though he did so much to further British aviation he received no medals, decorations, or honours in Britain. He wrote several books to interest the young in aviation and flew a Henri Farman on floats with the slogan WAKE UP, ENGLAND! on the nacelle for a propaganda tour of seaside resorts.

In 1925 he sold the aerodrome to the Air Ministry for, he assured me recently, £800,000.

After selling Hendon in 1925 he gave up active interest in flying, and, devoting himself to real estate in Europe and America, prospered greatly.

He married Miss Dorothy Taylor in 1912 and arrived in a field by the church in his Farman for the wedding. That marriage was dissolved and he married the popular actress Miss Ethel Levey. And after that too was dissolved he married Miss Phoebe Lee who survives him.—G.D.

Air Transport

B.E.A. Beats the Depression

ONE of the difficulties in dealing with the reports of our two airline Corporations is that these are necessarily published so long after the end of the period which is being examined. Now, nearing the end of a summer which has been a very satisfactory one indeed for B.E.A., it is hard to take one's mind back to the months of depression included in the period covered by the Corporation's report for 1958-59, which was published earlier this week.

The effect on B.E.A. of the European sub-depression is shown starkly by two figures. Whereas the ton-mile capacity for the year was planned on the assumption of an increase of at least 15%—with an extra 13% actually provided—traffic increased by no more than 7.2%. The situation was not helped by the unusually bad 1958-59 winter. Between November and February 937 services were disrupted, with the aircraft either diverted or returned to the take-off point, and the incidence of fog or low cloud in Southern England was higher than in any winter since 1948-49. The fact that B.E.A. shows a clear, if small, profit for the financial year is, therefore, a satisfactory one.

Financial

	1958/59	1957/58	Variation
			%
Traffic revenue	£30,597,438	£27,352,057	+11.9
Total revenue	£31,761,313	£28,340,725	+12.1
Exp. on operating account	£30,302,824	£26,465,070	+14.5
Total expenditure	£31,528,618	£27,285,918	+15.5
Profit before charging interest	£1,354,023	£1,858,887	−27.2
Profit	£232,695	£1,054,807	−77.9

Traffic

	1958/59	1957/58	Vatiation
			%
C.T.M. offered	181,054,643	160,281,788	+13.0
L.T.M. sold	109,365,684	102,062,347	+ 7.2
Revenue load factor (%)	60.4	63.7	− 5.2
Break-even load factor (%)	60.0	61.3	− 2.1
Cost per C.T.M. (pence)	41.8	40.9	+ 2.2
Revenue per C.T.M. (pence)	42.1	42.4	0.7
Revenue per L.T.M. (pence)	69.7	66.6	+ 4.7
Passengers carried	2,828,715	2,765,591	+ 2.3
Revenue passenger-miles	988,328,781	935,755,877	+ 5.6
Available seat-miles	1,581,095,727	1,365,093,800	+15.8
Passenger load factor (%)	62.5	68.5	− 8.8
Mail carried (tons)	7,669	7,465	+ 2.7
Mail ton-miles	4,057,872	3,599,500	+12.7
Freight carried (tons)	28,020	24,555	+14.1
Freight ton-miles	11,619,549	9,925,764	+17.1

Staff and Productivity

	1958/59	1957/58	Variation
			%
Average number of employees	11,606	11,011	+5.4
C.T.M. per employee	15,600	14,557	+7.2
Revenue per employee	£2,737	£2,574	+6.3

Once again the report shows a heavy loss (£1,700,000) on domestic services, with those in the Highlands and Islands losing £335,000 and those in the Irish Sea area losing £413,000. The biggest traffic decreases were shown in the Irish Sea operations (17%), in those between the U.K. provinces and European continent (15%) and on the Paris run (11%). The fact that there were increases averaging about 10% on the services between the U.K. and the Continent as largely due to the Brussels Exhibition; without the 80% increase in the traffic to and from the Belgian capital the overall increase might not have exceeded 4%. Other big traffic increases were on the German domestic services (31%) and on those to and from the Eastern Mediterranean (25%). Significantly, B.E.A.'s charter and inclusive tour traffic increased by a substantial amount.

Jersey Developments

JERSEY AIRPORT has assumed new importance as a major air traffic control centre with the introduction of the new Blue 32 airway for aircraft flying from Shannon to Paris, and the proposed Blue One route from Jersey to London Airport. In addition, Jersey A.T.C.C. now supervises the Channel Islands Control Zone up to a height of 20,000 ft. The proposed Blue One route, from 4,500 ft. to 17,000 ft., feeds into Amber Two over Rye; Jersey control extends along it as far as the F.I.R. boundary at 50° N., including the portion of the route lying across the Cherbourg Peninsula.

Traffic in Blue 32 airway, between 6,000 ft. and 20,000 ft., overflies Jersey, and the co-ordination of this with terminal traffic calls for close control. To meet this new requirement, Marconi 50-kW. long-range surveillance radar Type S264 has been installed and was inaugurated by H.R.H. Princess Margaret on June 26. Similar equipment, but in its longer-range 500-kW. version, will be installed at London Airport and Ringway. The S264 operates on a 50-cm. wavelength and includes crystal control, a moving-target indicator, video mapping and inter-trace marking. Maximum range is 100 miles.

When the M.T.C.A. has completed its radar installation programme for the South Coast of England, the Jersey radar will overlap the English coverage to give complete radar monitoring of aircraft flying between the Channel Islands and London.

A complete new G.E.C. airfield lighting system has now been installed at Jersey Airport, where the runway is also being extended from 4,450 ft. to 5,000 ft. The equipment includes high-intensity runway lights, threshold lights and wing bars, all controllable in five stages of brightness, and improved approach lighting.

The high-intensity runway lights are elevated (10½ in. max.), mounted on a frangible base and spaced at 200-ft. intervals along the sides of the runway; they are beamed for maximum intensity on approach from either end, but also have an omni-directional light component at a low intensity. Flight impressions of similar runway lighting laid down at Southend appeared in our issue of June 27, 1958 (p. 904).

DOUGLAS CONTENDERS.—On the apron at Long Beach are five completed DC-8s with a U.S.A.F. C-133 on the far right. The ninth DC-8, the first of the Conway-powered versions, flew on July 23.

Short-haul Contenders

WITH the release of detailed information about the Airco D.H.121 and the Douglas DC-9 it is both natural and educative to study these two short-haul turbojets in relation to each other. Although there are radical differences in configuration—one is a three-engined "aft-ender" and the other has four podded engines—there are also remarkable similarities between the solutions reached by the two design teams. Also, although there is one significant difference in performance—that of design range—in many other respects the similarities are notable.

For ease of reference and comparison, we have summarized side by side below the major characteristics of the two types. It is worth noting, too, that both have progressed through a lengthy period of gestation, during which their characteristics have changed considerably. When the DC-9 was first planned, in mid-1956, it was thought of as a medium-haul rather than short-haul aeroplane, weighing perhaps 140,000 lb. and with at least 40,000 lb. of thrust. Its size was set at four-fifths that of the DC-8, giving a wing area of 1,770 sq. ft. At that time, deliveries were promised by mid-1961 if ordered.

This project formed the basis for discussion with at least 30 airlines, in light of which the study has been constantly revised. Early in 1958, a twin-JT-4 version weighing 125,000 lb., for delivery in 1962, was being canvassed; but all along Douglas have been aware of a lack of really suitable powerplants coupled with the need to get the DC-8 established before embarking on a second type. The advent of the turbofan last year resolved one difficulty and, with the DC-8 due to go into service with United Air Lines next month, both objections have now been overcome. However, the company still has no orders and the promised early-1963 delivery date is clearly conditional on sufficient orders—Douglas want 75-100—being obtained quite soon. As announced in June, the DC-9 has shrunk to 120,000 lb., but is still in the short-to-medium-haul category to meet the needs of U.S. transcontinental operators.

The D.H.121 had its origins in the B.E.A. Outline Specification for a short-haul turbojet which was put out to the industry in August, 1956. This specified a 600-m.p.h. aeroplane carrying 70 passengers over a 1,000-naut. mile stage distance, and operating from 6,000-ft. fields. When this specification was issued, de Havilland were studying the D.H.118, a project intended to meet B.O.A.C. requirements for a medium-long-haul jet. The first attempt to satisfy B.E.A. was made with the four-Avon D.H.119, and then, with the D.H.120, the possibility of meeting both B.E.A. and B.O.A.C. requirements with one aeroplane was studied. This, however, satisfied neither Corporation, so, while B.O.A.C. went to Vickers (suppliers of B.E.A.'s Viscount fleet), de Havilland (suppliers of the B.O.A.C. Comets) concentrated on the B.E.A. requirement exclusively with the D.H.121.

By the middle of 1957, this design had been chosen by B.E.A. in preference to those submitted by Bristol, Vickers and Avro. At this stage, negotiations became bedevilled by political considerations, since the Ministry of Supply saw in the B.E.A. contract a means of bringing the Bristol and Hawker Siddeley groups together in an integrated unit. Not until February, 1958, did B.E.A. obtain Treasury authority to order its fleet of D.H.121s. The Corporation was then talking in terms of a 120,000-lb. aeroplane carrying 100 passengers (high density) and with three 12,000-lb. R.B.141 engines.

In the year that followed, two factors influenced the growth of the D.H.121 beyond this point. One was the rapid power development of the R.B.141 to 14,000 lb. in its Stage 3 version; the other was the view of some in B.E.A. who were eager to stretch the size and range to take advantage of this power growth.

A divergence of opinion both within B.E.A. and between B.E.A. and D.H. as to the wisdom of this growth led eventually, in the early months of this year, to a complete reassessment which has brought the D.H.121 back in size at least to where it was in 1957. And it is the "optimization" of the design for stages of not more than 1,200 miles which gives the D.H.121 its encouragingly low operating costs and high performance on which its success over the DC-9 may ultimately depend.

THE AIRCO D.H.121

Makers. Aircraft Manufacturing Co., Ltd., comprising the de Havilland Aircraft Co., Ltd. (67½%); Hunting Aircraft, Ltd. (22½%) and the Fairey Aviation Co., Ltd. (10%). Chief designer, C. T. Wilkins, O.B.E., F.R.Ae.S.

Production Status. Project design complete. In detail design. Some structure testing. Tooling well advanced; some components in work. Twenty-four ordered by British European Airways, August 12, 1959. First flight 1961, production deliveries last quarter of 1963. Principal production unit, Hatfield, Herts.

Powerplant. Three Rolls-Royce R.B.163 by-pass engines, rated at 10,100 lb.s.t. each. Convergent nozzles with silencers on all three; thrust reversers on two outers.

Control System. Double-slotted flaps in four portions with inter-connected leading-edge flaps. Two-piece ailerons each side, inner portions alone for high speeds; hydraulically powered. One spoiler as lift dumper and one air brake on each wing. Hydraulically powered rudder. All-moving tailplane with geared elevator.

Undercarriage. Four-wheel main units, pivoting through 90° and retracting into fuselage. Twin wheel off-set nosewheel, sideways retracting. Hydraulic brakes.

Accommodation. Ranging from 75 first and economy-class, four and five abreast, to 97 economy-class, six abreast. Airstairs at front passenger entrance.

Dimensions. Span, 89 ft. 10 in.; o.a. length, 114 ft. 9 in.; o.a. height, 27 ft. 6 in.; gross wing area, 1,350 sq. ft.; sweepback, 35°; cabin length, 64 ft.; max. cabin width, 139.5 in.; max. cabin height, 80 in.; baggage holds, 620 cu. ft.

Weights and Loadings. Space-limited payload, 21,500 lb.; zero fuel weight, 85,000 lb.; max. landing weight, 100,000 lb.; max. t.o. weight, 105,000 lb.; t.o. wing loading, 77.8 lb./sq.ft.; t.o. power loading, 3.46 lb./lb.s.t.

Performance. High-speed cruise, M=0.875 at 25,000 ft.; cost-economy cruise, M=0.87 at 32,000 ft. Balanced take-off (B.C.A.R., 1959), 6,000 ft. in I.S.A. at s.l. Still-air range, typical reserves with 21,500-lb. payload (97 passengers), 720 naut. miles; with 16,000-lb. payload, 1,040 naut. miles; with max. fuel and 12,000-lb. payload, 1,575 naut. miles.

Costs. First cost, approx. £1 million each. Minimum direct operating costs (A.T.A. method, 10-year depreciation and 15% residual), 1.2 cents/capacity seat nautical mile (97 passengers for 800 naut. miles); 1.4 cents/capacity seat nautical mile (79 passengers for 1,000 naut. miles).

THE DOUGLAS DC-9

Makers. Douglas Aircraft Co., Santa Monica, California. Senior vice-president, engineering, A. E. Raymond; vice-president, transport aircraft systems engineering, E. F. Burton.

Production Status. Project design complete. In detail design. Much tooling interchangeable with DC-8. Production decision depends on orders being obtained for 75-100; no contracts announced. Deliveries promised early 1963 if ordered now. Principal production unit, Santa Monica.

Powerplant. Four Pratt & Whitney JTF-10A-1 turbofans rated at 8,250 lb.s.t. each. Silencers and Douglas thrust reversers (40% reversal) on each.

Control System. Double-slotted flaps in two (28%) portions with interconnected leading-edge flaps (15%). Interconnected two-piece ailerons each side; inner portions, hydraulically boosted, for high speeds. Spoilers in three pieces ahead of flaps, each side, as lift dumpers; two outboard spoilers also operate in conjunction with ailerons when u/c is down. Supplementary air braking by reverse thrust. Hydraulically boosted rudder. Manual elevator and hydraulic v.i. tailplane.

Undercarriage. Four-wheel main units, retracting into fuselage. Single nose-wheel, forward retracting. Hydraulic brakes.

Accommodation. Ranging from 68 first-class, four-abreast, to 92 coach-class, five abreast. Airstairs at front passenger entrance.

Dimensions. Span, 94 ft.; o.a. length, 103 ft.; o.a. height, 34 ft.; gross wing area, 1,285 sq. ft.; sweepback, 30°; cabin length, 71 ft.; max. cabin width, 124 in.; max. cabin height, 81 in.; baggage holds, 609 cu. ft.

Weights and Loadings. Max. payload, 20,355 lb.; zero fuel weight, 87,000 lb.; max. landing weight, 98,000 lb.; max. t.o. weight, 120,000 lb. T.o. wing loading, 93.3 lb./sq. ft.; t.o. power loading, 3.6 lb./s.t.

Performance. Cruising speed, M=0.84 at 35,000 ft.; balanced field length (SR422A), 5,950 ft. in I.S.A. at s.l. Still-air range, typical reserves, with 20,355-lb. payload, 1,735 naut. miles; with 17,130-lb. payload, 2,000 naut. miles; with max. fuel and 14,500-lb. payload, 2,160 naut. miles.

Costs. First cost, approx. $3 million. Minimum direct operating costs (A.T.A. method, 10-year depreciation), 1.5 cents/capacity passenger mile (68 passengers for 2,486 st. miles).

Two conferences of major importance to the space-sciences are being held at Church House, Westminster. Here KENNETH GATLAND* reviews the Commonwealth Spaceflight Symposium and, on page 63, ANDREW G. HALEY gives the background to next week's 10th Congress of the International Astronautical Federation.

COMMONWEALTH ASTRONAUTICS

THAT the Government's limited programme of space-research does not entirely satisfy the engineering fraternity will be apparent from the proceedings of the Commonwealth Spaceflight Symposium which opened at Church House, Westminster, on August 27. No fewer than 11 papers are being given by leading aircraft and missile manufacturers.

The aim of the Symposium, which brings together speakers from Australia, Canada, Gt. Britain, India and South Africa, is to explore the prospects for collaboration, embracing Commonwealth research and manufacturing centres, universities and colleges, launching sites and tracking facilities.

The suggestion that such a meeting should be held originated during informal discussions by Commonwealth delegates attending the 9th Congress of the International Astronautical Federation in Amsterdam last year. The Symposium has been organized by the British Interplanetary Society.

One aspect being stressed by speakers is that space-research cannot profitably be limited, as at present, to geophysical studies, but must be developed on a much broader front. Many vital commercial applications for the space-sciences are opening up, ranging from space-borne repeater stations for radio, T.V., and communication services generally, to weather survey, navigation and world mapping. At the present time great interest is being shown in satellites for the surveillance of nuclear tests conducted in space, while a watchful eye must also be kept on direct military applications. The Americans are already developing reconnaissance satellites and a satellite detection system against ballistic missile attack.

Launching Vehicles

In satellite tracking, Britain's "private venture" facility at Jodrell Bank has won high praise the World over. But if this country is to keep abreast of the practical outlets for space-research, it is vital that we produce not only the instruments but the launching vehicles as well. Fortunately, in the Blue Streak, we have an excellent booster stage for any space-programme we can currently envisage, adequate—with suitable upper staging—for the launching of communication satellites and space-research missions of many kinds. However, if we are to play any useful part in such activities, no time can be lost in developing the vehicle for satellite work, bearing in mind the time it will take to carry out the modifications and develop a suitable upper stage.

Nor must manned space-flight be overlooked. The more permanent satellite stations, when they come, will not be absolutely reliable and, in consequence, there will surely be a need for man-carrying, manœuvrable, satellites to enter orbit and perform servicing operations.

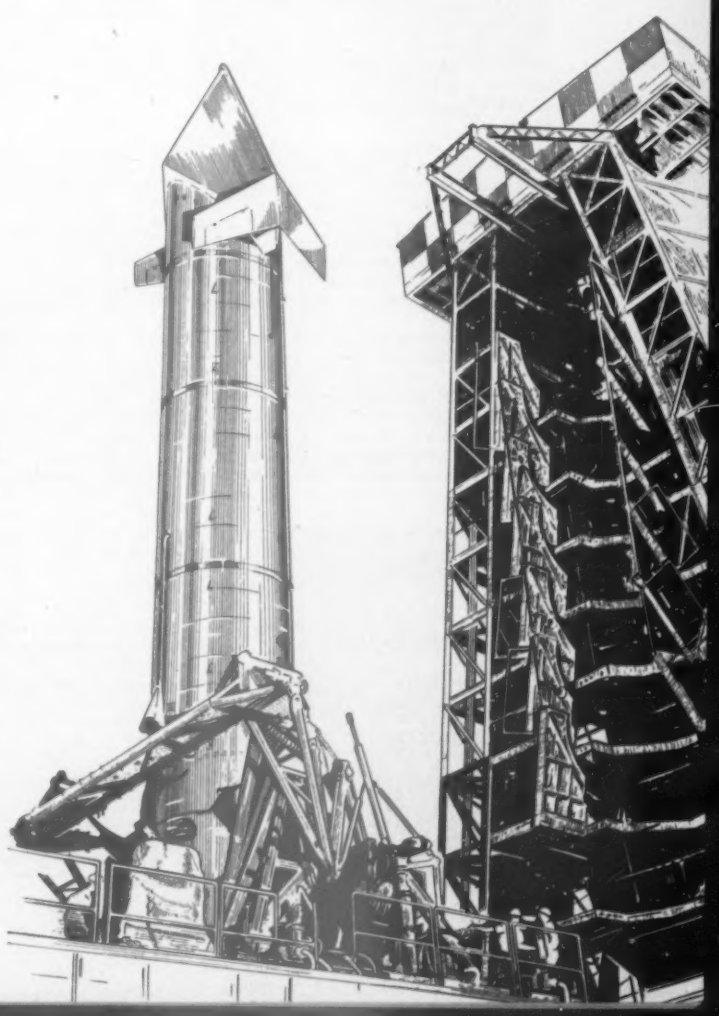
Thus, we cannot expect to take advantage of astronautics as an applied science, or keep our heads above water as a modern engineering community, unless we are at work in the space-sciences generally. It is the case of the supersonic airliner all over again; we *must* engage in these developments if we are to preserve our time-honoured proficiency in science and engineering.

Economics

The question is not so much, *shall* these things be done, but *how* can they be achieved economically? In one respect, our situation is beneficial to the quest for we cannot afford extravagant methods. The Americans, with almost total disregard to cost, have never been subjected to our kind of discipline. In any co-operative effort between ourselves, the Commonwealth and the United States, which surely must be forthcoming, our experience in doing things cheaply may be invaluable. Indeed, there are indications that America's massive space-effort cannot be sustained as a lone effort in the years ahead, not only from the viewpoint of hard economics but simply because scientific manpower is at a premium. We must take it that the future of astronautics is bound up with collaboration of some kind.

Whether this ideal can be eventually made to include Russia and the other Iron Curtain countries remains to be seen, but the point is worth making that the military obstacles will not

* Programme Chairman.



An artist's impression of the Armstrong Whitworth manned satellite project.

last forever. Rocket technique is now fairly well understood the World over, and just as the atomic bomb, once the most top-secret device on the planet, is now capable of being manufactured by almost any nation with industrial background, so rockets will cease to have the security stigma they have today.

Limited Co-operation

Whatever the prospects may be for World collaboration in astronautics, the idea of limited co-operation is very pertinent to the development of astronautics in this country and the Commonwealth, as the current London Symposium sets out to illustrate.

An extremely wide range of topics is being covered at Church House, ranging from the economics of small solid-propellent rockets, to hypersonic ram-jet boosters, space-vehicles launched from bombers, and the manned satellite. They show that Britain's industrial leaders are well aware of the potential that exists in space-flight although, as they point out, real progress can only be made with Government help.

"Astronautics at Armstrong Whitworths" is the title of a paper by Mr. H. R. Watson, which describes the results of a two-year educational exercise which the company undertook on their own initiative following the launching of Sputnik I.

The work began as a detailed investigation of the ideas of Dr. W. F. Hilton, then chief aerodynamicist at A.W.A., who had done considerable private research into the problems of re-entering a manned vehicle from orbit. Dr. Hilton had originally discussed a saucer-shaped re-entry vehicle at the Symposium on High Altitude and Satellite Rockets jointly organized by the British Interplanetary Society, the Royal Aeronautical Society, and the College of Aeronautics at Cranfield in July, 1957.

Following the launching of the Russian satellite, direct company interest in Dr. Hilton's ideas was aroused. It was decided that a small team in the aerodynamics laboratory should investigate this new field in a preliminary way with the aim of educating the people involved to the stage where they could reasonably be entrusted with an astronautical project under Government ægis.

The astronautics team was placed under the control of Mr. H. R. Watson, the company's technical director, who was called upon to apply his wide experience in aircraft design to the overall concept.

Controlled Satellite

First objective was to confirm Dr. Hilton's reasoning that, for the purpose of the preliminary study, the objective should be a manned satellite vehicle that could be fully controlled as a flying machine in the upper atmosphere. This represented a departure from preliminary design thinking in America where the decision has been to concentrate first on a ballistic re-entry vehicle, the Mercury capsule, which in principle is little more than a detached nose-cone. What A.W.A. sought right from the start was a re-entry vehicle that could be controlled along a glide path.

In his private studies, Dr. Hilton had chosen a vehicle having a circular planform, which was designed to fly in the atmosphere at a very coarse angle of incidence, with the pilot enclosed and sheltered from the heat, in the vacuum or lee side of the disc. The circular configuration enabled the use of spin stabilization to maintain the attitude at heights when no aerodynamic control was available, rotation being confined to some outer annulus, with the pilot's capsule remaining stationary.

Mr. H. R. Watson, technical director, Sir W. G. Armstrong Whitworth Aircraft, Ltd. With Dr. Hilton, Mr. Watson has played a leading part in developing the concept of the "pyramid" re-entry vehicle.

As the work progressed from an individual to a company level, it was decided that a complete flight plan for a manned vehicle should be explored taking in the whole sequence of launching, orbital flight, re-entry, gliding flight and landing.

The initial assumption had been that the vehicle would be sufficiently compact to be housed in the forepart of a multi-stage rocket and that this forepart, or final stage, would separate at all-burnt, leaving the vehicle in free-flight above the atmosphere. Subsequently, it was found that the span of a vehicle to carry even one man would require an excessive cylinder diameter to enclose it and A.W.A. were forced to consider alternative solutions.

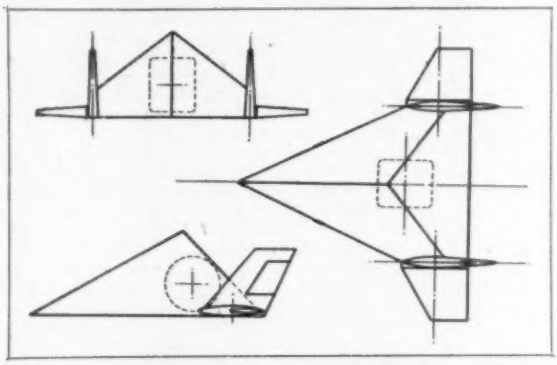
One was to mount an exposed flying machine in the nose of a multi-stage rocket which involved making the vehicle symmetrical with the overall rocket system. An asymmetric vehicle, it was pointed out, could hardly have a no-lift line coaxial with the whole system in both subsonic and supersonic flight.

This and other considerations led to a fundamental change in the configuration, which now assumed the planform of a delta with a flat undersurface and an upper portion of a pyramid shape. Within the pyramid at the aft end was situated a pressurized capsule for two men with facilities for emergency ejection.

Re-entry Heating

From the viewpoint of kinetic heating, there were two things to consider: first a low wing-loading, and second a configuration ensuring that the maximum proportion of total heat generated went into the wake and not into the vehicle.

The low wing-loading requirement raised an immediate problem, for the re-entry condition requires a large wing spread to avoid concentration of the heat due to drag. If the



A.W.A. "pyramid" re-entry vehicle: length 25 ft. 3 in., span 29 ft. 6 in., height 9 ft. 3 in., wing area 332 sq. ft.; "wing" structure weight at 5 lb./sq. ft. 1,660 lb.; fins 140 lb.; capsule, including two men, instruments, etc., 2,000 lb.; retro-rockets, propellent and tanks 200 lb.; control actuator, power supplies, etc., 120 lb. (total 4,120 lb.); wing loading 12.4 lb./sq. ft.

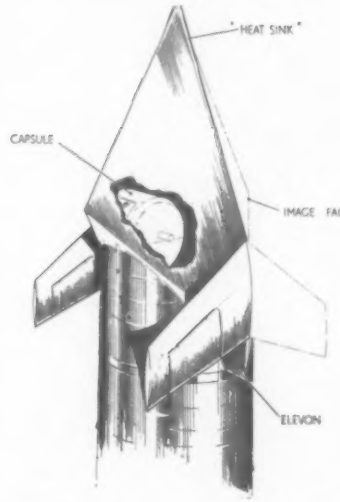
vehicle is to be mounted on, or in, a rocket casing for launching, it must be reasonably compact. Bearing in mind the second requirement to dispel heat into the surrounding air rather than into the vehicle, a high incidence and a fairly low value of $\frac{L}{D}$ appear desirable, as drag due to lift provides a form of deceleration which is not inevitably productive of vehicle heating.

It is admitted that lift, under certain flight conditions, may not be desirable, nor could it be satisfactorily reduced by reducing incidence. Its main effect on the re-entry path, the paper suggests, could be limited by rolling the vehicle first one way and then the other, so that it describes a sinusoidal path about the plane of its approximate great circle. By this means the lift component in the great circle plane, and hence the altitude of the path, can be controlled.

Staging the Vehicle

Following the general description of the vehicle, Mr. Watson next turned to the launching vehicle and the need to produce staging which kept acceleration within tolerable physiological limits. Calculation has shown that a three-stage vehicle with a launch weight of about 160 tons would be suitable for launching a two-man "pyramid" vehicle into an elliptical orbit with a perigee of about 80 miles and apogee of some 400 miles.

Of the problem of installing the orbital vehicle on the



"Pyramid" vehicle mounted on final stage.

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last forever. Rocket technique is now fairly well understood the World over, and just as the atomic bomb, once the most top-secret device on the planet, is now capable of being manufactured by almost any nation with industrial background, so rockets will cease to have the security stigma they have today.

Limited Co-operation

Whatever the prospects may be for World collaboration in astronautics, the idea of limited co-operation is very pertinent to the development of astronautics in this country and the Commonwealth, as the current London Symposium sets out to illustrate.

An extremely wide range of topics is being covered at Church House, ranging from the economics of small solid-propellent rockets, to hypersonic ram-jet boosters, space-vehicles launched from bombers, and the manned satellite. They show that Britain's industrial leaders are well aware of the potential that exists in space-flight although, as they point out, real progress can only be made with Government help.

"Astronautics at Armstrong Whitworths" is the title of a paper by Mr. H. R. Watson, which describes the results of a two-year educational exercise which the company undertook on their own initiative following the launching of Sputnik I.

The work began as a detailed investigation of the ideas of Dr. W. F. Hilton, then chief aerodynamicist at A.W.A., who had done considerable private research into the problems of re-entering a manned vehicle from orbit. Dr. Hilton had originally discussed a saucer-shaped re-entry vehicle at the Symposium on High Altitude and Satellite Rockets jointly organized by the British Interplanetary Society, the Royal Aeronautical Society, and the College of Aeronautics at Cranfield in July, 1957.

Following the launching of the Russian satellite, direct company interest in Dr. Hilton's ideas was aroused. It was decided that a small team in the aerodynamics laboratory should investigate this new field in a preliminary way with the aim of educating the people involved to the stage where they could reasonably be entrusted with an astronautical project under Government ægis.

The astronautics team was placed under the control of Mr. H. R. Watson, the company's technical director, who was called upon to apply his wide experience in aircraft design to the overall concept.

Controlled Satellite

First objective was to confirm Dr. Hilton's reasoning that, for the purpose of the preliminary study, the objective should be a manned satellite vehicle that could be fully controlled as a flying machine in the upper atmosphere. This represented a departure from preliminary design thinking in America where the decision has been to concentrate first on a ballistic re-entry vehicle, the Mercury capsule, which in principle is little more than a detached nose-cone. What A.W.A. sought right from the start was a re-entry vehicle that could be controlled along a glide path.

In his private studies, Dr. Hilton had chosen a vehicle having a circular planform, which was designed to fly in the atmosphere at a very coarse angle of incidence, with the pilot enclosed and sheltered from the heat, in the vacuum or lee side of the disc. The circular configuration enabled the use of spin stabilization to maintain the attitude at heights when no aerodynamic control was available, rotation being confined to some outer annulus, with the pilot's capsule remaining stationary.

Mr. H. R. Watson, technical director, Sir W. G. Armstrong Whitworth Aircraft, Ltd. With Dr. Hilton, Mr. Watson has played a leading part in developing the concept of the "pyramid" re-entry vehicle.

As the work progressed from an individual to a company level, it was decided that a complete flight plan for a manned vehicle should be explored taking in the whole sequence of launching, orbital flight, re-entry, gliding flight and landing.

The initial assumption had been that the vehicle would be sufficiently compact to be housed in the forepart of a multi-stage rocket and that this forepart, or final stage, would separate at all-burnt, leaving the vehicle in free-flight above the atmosphere. Subsequently, it was found that the span of a vehicle to carry even one man would require an excessive cylinder diameter to enclose it and A.W.A. were forced to consider alternative solutions.

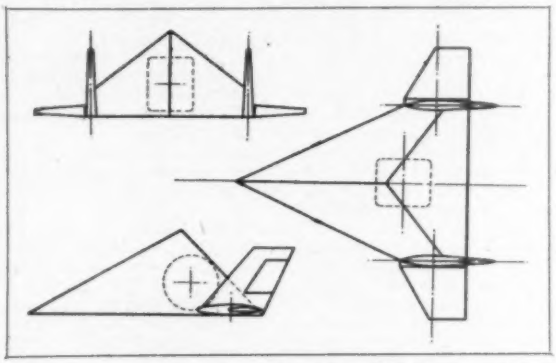
One was to mount an exposed flying machine in the nose of a multi-stage rocket which involved making the vehicle symmetrical with the overall rocket system. An asymmetric vehicle, it was pointed out, could hardly have a no-lift line coaxial with the whole system in both subsonic and supersonic flight.

This and other considerations led to a fundamental change in the configuration, which now assumed the planform of a delta with a flat undersurface and an upper portion of a pyramid shape. Within the pyramid at the aft end was situated a pressurized capsule for two men with facilities for emergency ejection.

Re-entry Heating

From the viewpoint of kinetic heating, there were two things to consider: first a low wing-loading, and second a configuration ensuring that the maximum proportion of total heat generated went into the wake and not into the vehicle.

The low wing-loading requirement raised an immediate problem, for the re-entry condition requires a large wing spread to avoid concentration of the heat due to drag. If the



A.W.A. "pyramid" re-entry vehicle: length 25 ft. 3 in., span 29 ft. 6 in., height 9 ft. 3 in., wing area 332 sq. ft.; "wing" structure weight at 5 lb./sq. ft. 1,660 lb.; fins 140 lb.; capsule, including two men, instruments, etc., 2,000 lb.; retro-rockets, propellent and tanks 200 lb.; control actuator, power supplies, etc., 120 lb. (total 4,120 lb.); wing loading 12.4 lb./sq. ft.

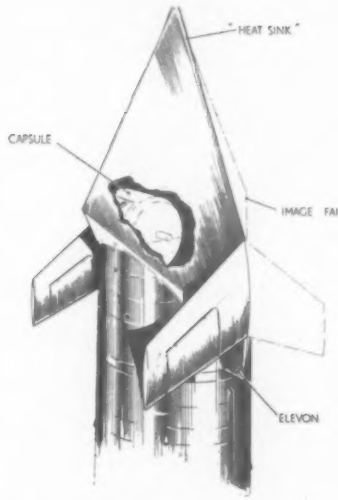
vehicle is to be mounted on, or in, a rocket casing for launching, it must be reasonably compact. Bearing in mind the second requirement to dispel heat into the surrounding air rather than into the vehicle, a high incidence and a fairly low value of $\frac{L}{D}$ appear desirable, as drag due to lift provides a form of deceleration which is not inevitably productive of vehicle heating.

It is admitted that lift, under certain flight conditions, may not be desirable, nor could it be satisfactorily reduced by reducing incidence. Its main effect on the re-entry path, the paper suggests, could be limited by rolling the vehicle first one way and then the other, so that it describes a sinusoidal path about the plane of its approximate great circle. By this means the lift component in the great circle plane, and hence the altitude of the path, can be controlled.

Staging the Vehicle

Following the general description of the vehicle, Mr. Watson next turned to the launching vehicle and the need to produce staging which kept acceleration within tolerable physiological limits. Calculation has shown that a three-stage vehicle with a launch weight of about 160 tons would be suitable for launching a two-man "pyramid" vehicle into an elliptical orbit with a perigee of about 80 miles and apogee of some 400 miles.

Of the problem of installing the orbital vehicle on the



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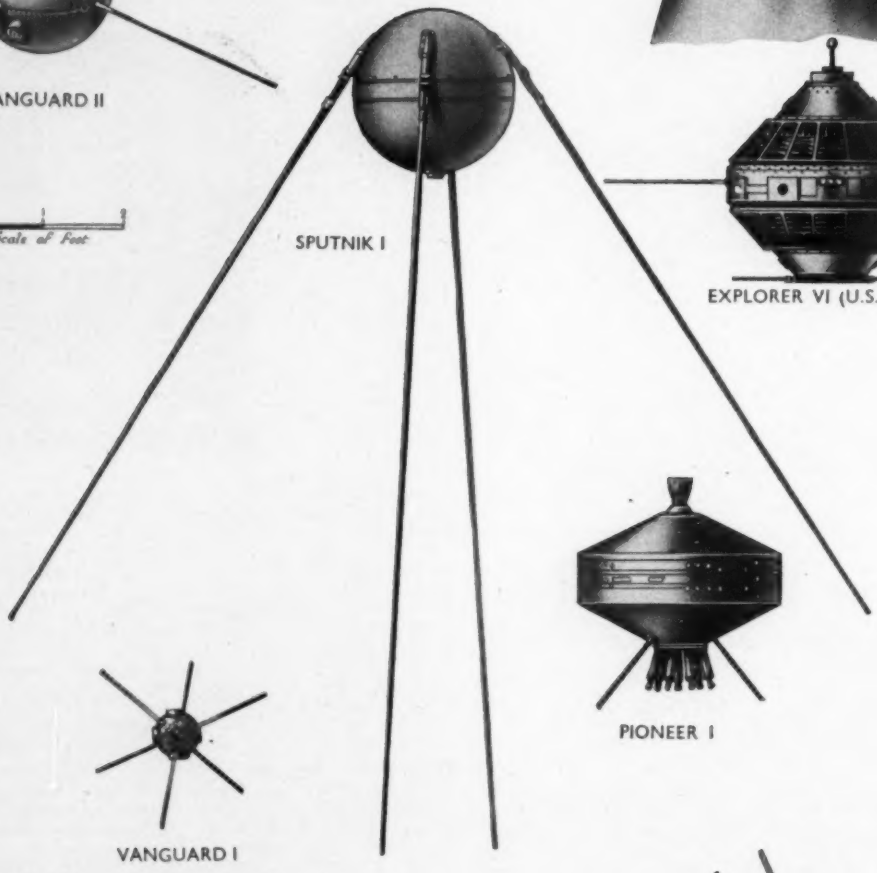
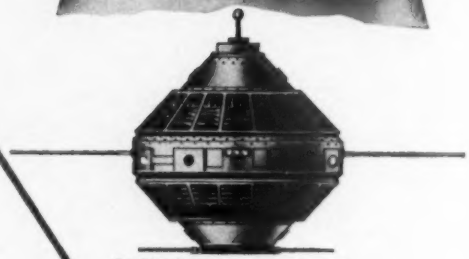
SATELLITES AND SPACE ROCKETS

SPUTNIK II

VANGUARD II



SPUTNIK I

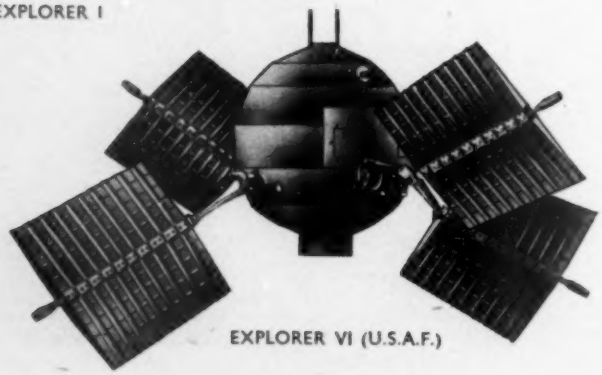


EXPLORER VI (U.S. Army)

EXPLORER I

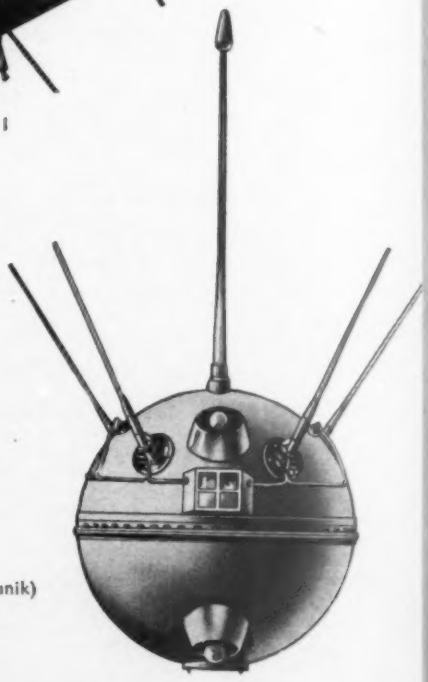
VANGUARD I

PIONEER I

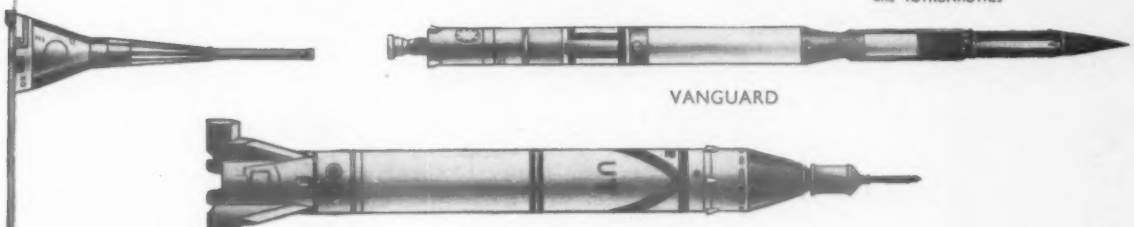


EXPLORER VI (U.S.A.F.)

PIONEER III

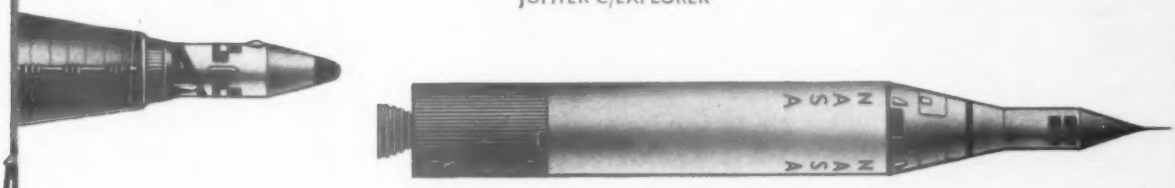


MECHTA (or Lunik)

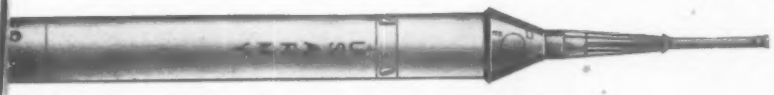


VANGUARD

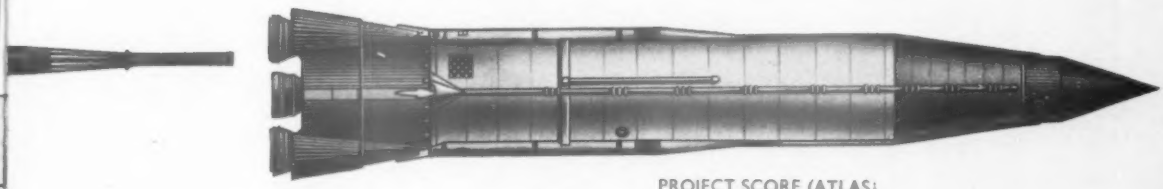
JUPITER C/EXPLORER



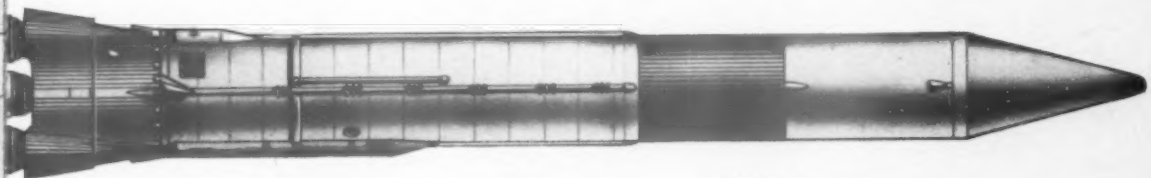
JUNO II



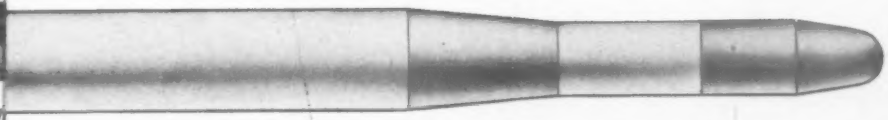
REDSTONE-MERCURY



PROJECT SCORE (ATLAS)



CENTAUR



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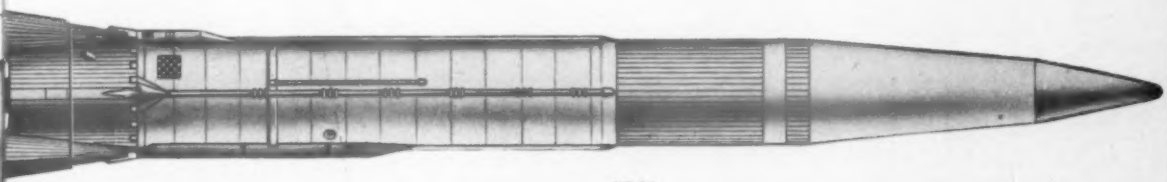
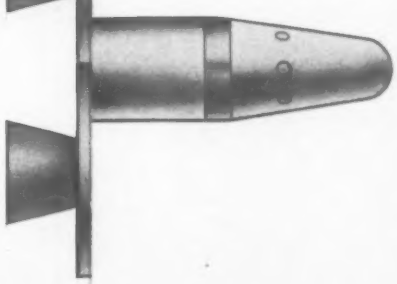
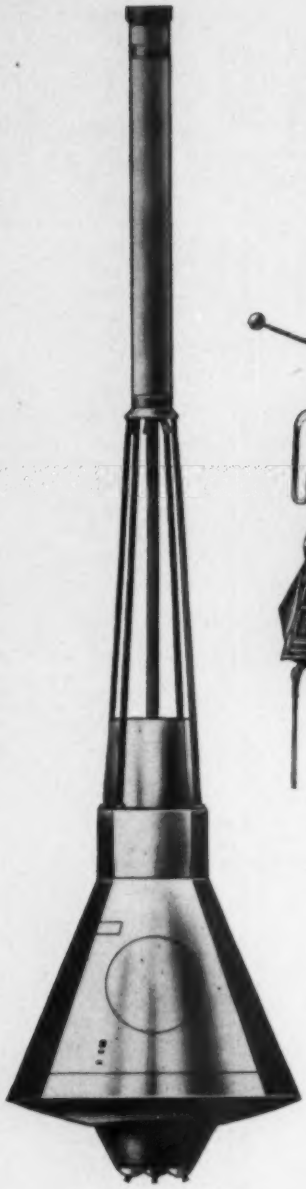


VEGA

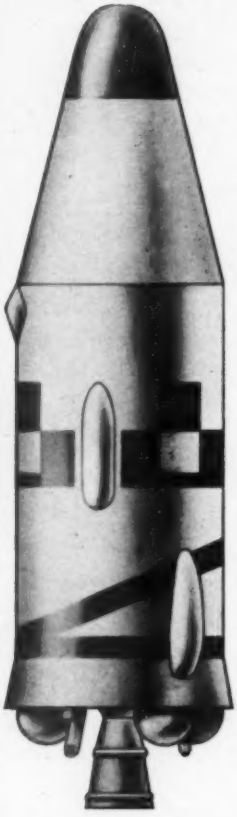


ASTRONAUTICS HARDWARE.—So swiftly are the space-sciences advancing that it is difficult to keep abreast of developments. On these pages we present a pictorial analysis of all the major space-vehicles both actual and envisaged. On the reverse pages will be found a comprehensive record, with full data, of all the satellites and space-probes launched up to August 13, 1959. For details of vehicles illustrated but not yet launched (italicized in the pictorial survey), turn to page 61.



MERCURY CAPSULE

SPUTNIK III



DISCOVERER II

The three largest satellites, Atlas (Score) excluded, compared to scale.

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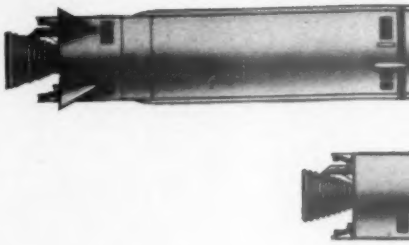
Scale of Feet



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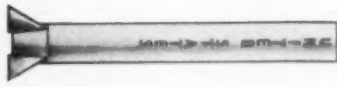

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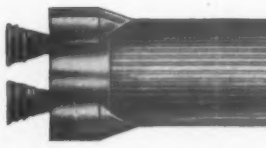
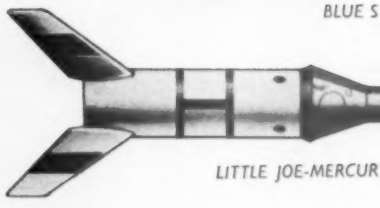
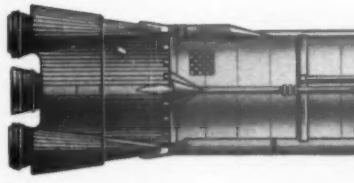
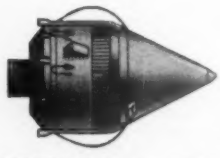


BLUE S

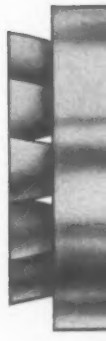


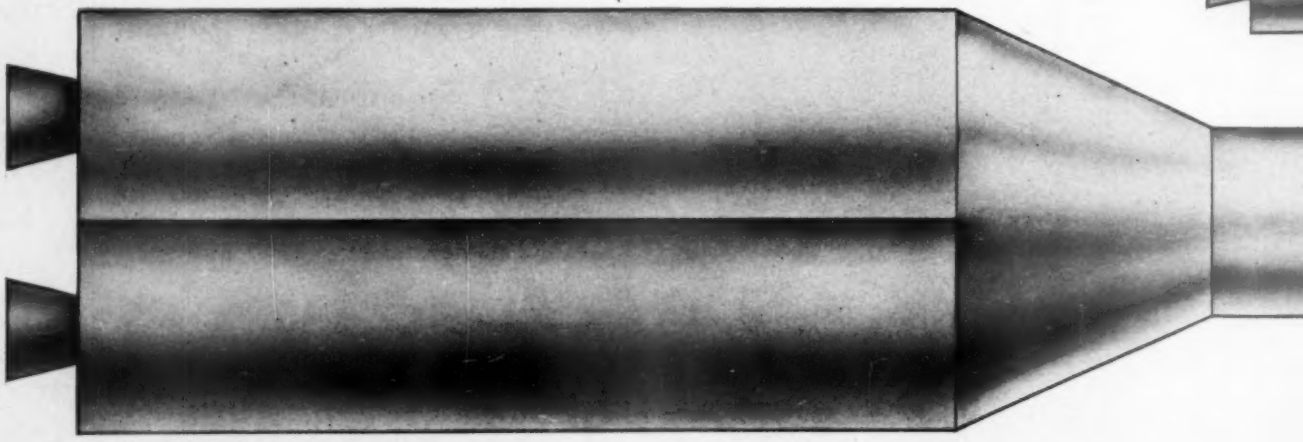
LITTLE JOE-MERCUR





MECHTA (final stage only)





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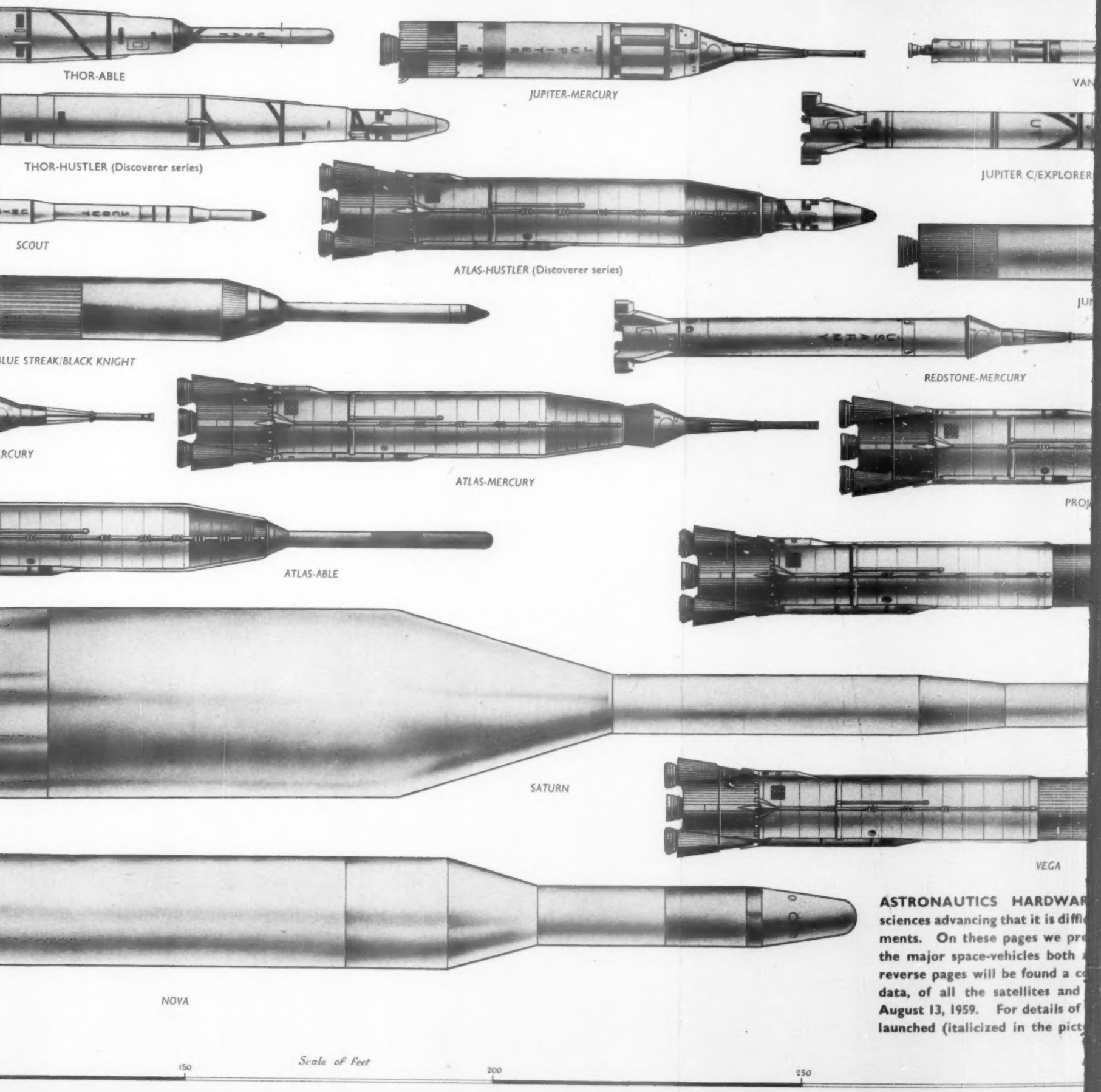

ASTRONAUTICS HARDWAR
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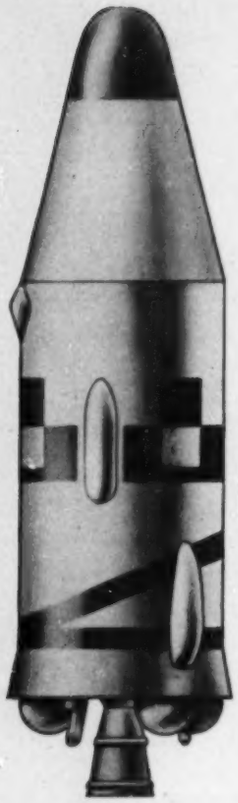
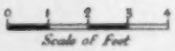
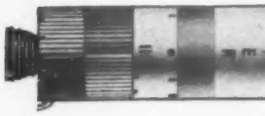
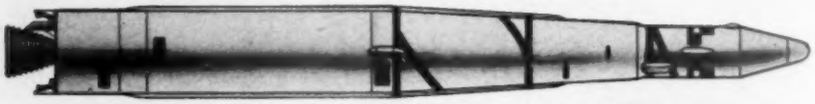


DISCOVERER II



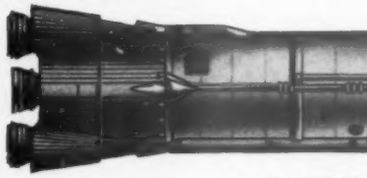
THOR-ABLE





THOR-HUSTLER (Discoverer series)

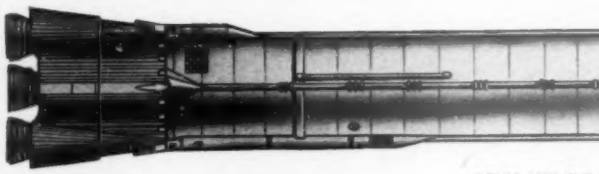
SCOUT



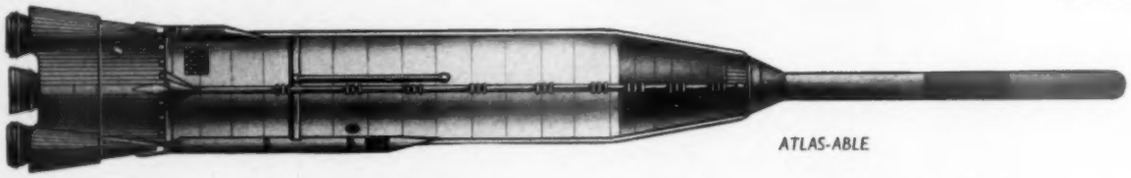
ATLAS-HUSTLER

BLUE STREAK/BLACK KNIGHT

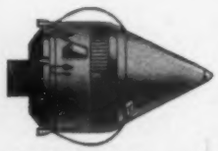
LITTLE JOE-MERCURY



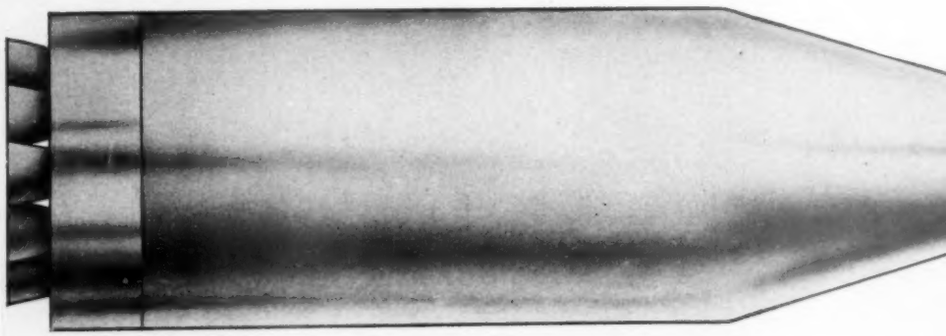
ATLAS-MERCURY

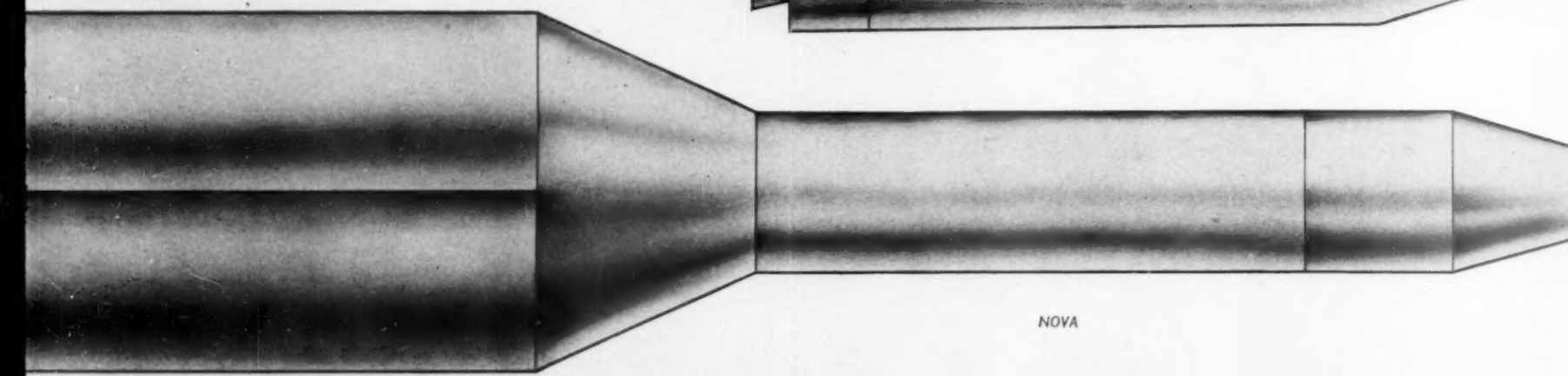


ATLAS-ABLE

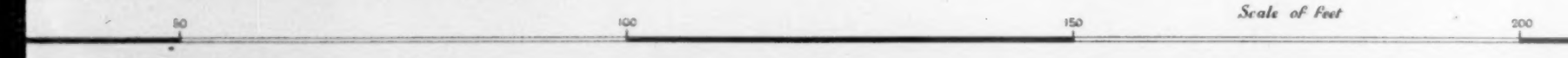


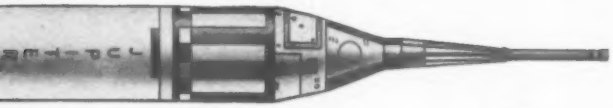
MECHTA (final stage only)



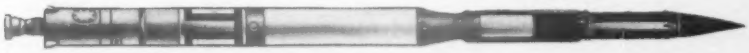


NOVA

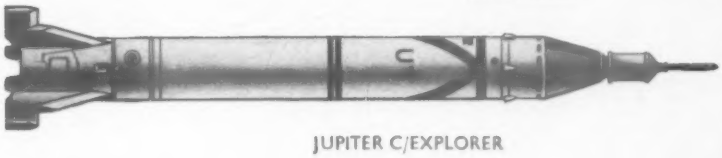




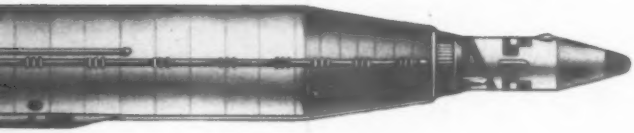
JUPITER-MERCURY



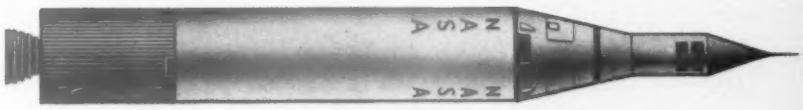
VANGUARD



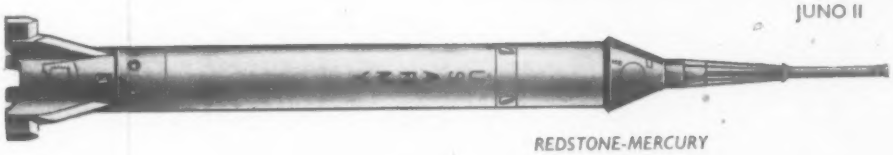
JUPITER C/EXPLORER



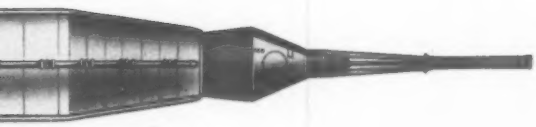
TLER (Discoverer series)



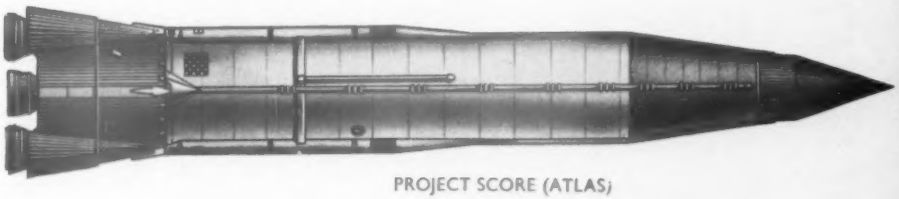
JUNO II



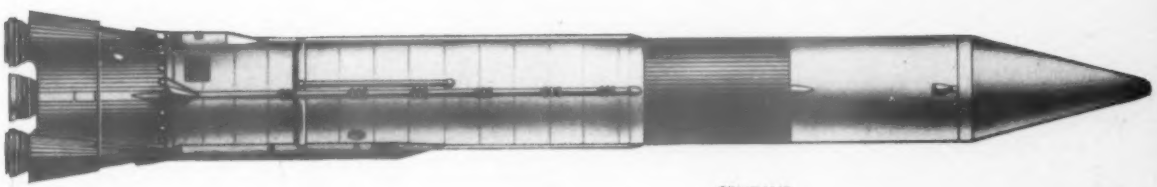
REDSTONE-MERCURY



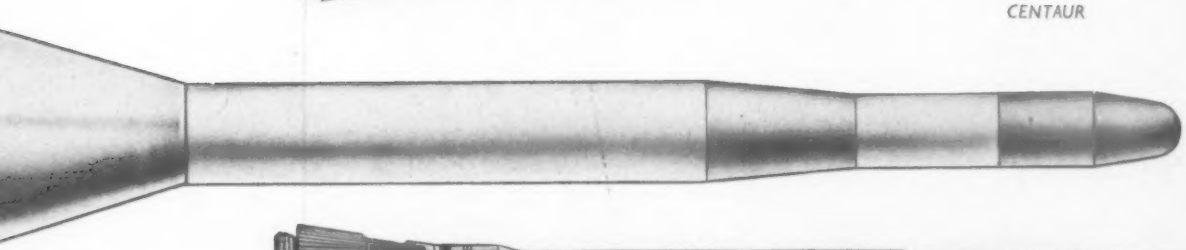
RCURY



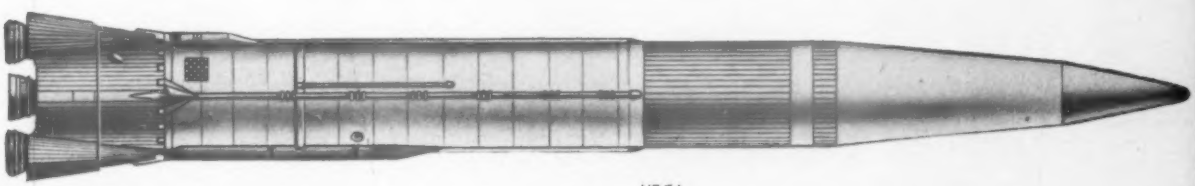
PROJECT SCORE (ATLAS)



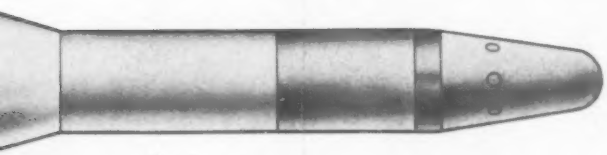
CENTAUR



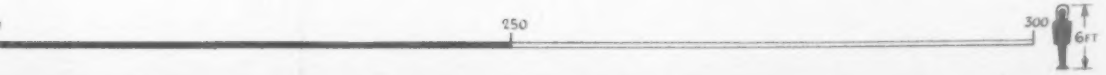
SATURN



VEGA



ASTRONAUTICS HARDWARE.—So swiftly are the space-sciences advancing that it is difficult to keep abreast of developments. On these pages we present a pictorial analysis of all the major space-vehicles both actual and envisaged. On the reverse pages will be found a comprehensive record, with full data, of all the satellites and space-probes launched up to August 13, 1959. For details of vehicles illustrated but not yet launched (italicized in the pictorial survey), turn to page 61.



RECORD OF ALL KNOWN SPACE-VEHICLE LAUNCHES

Corrected to August 13, 1959

Name	Lifetime	Shape and size	Weight	Shell material	Experiments	Radio				Orbit				Launching site and vehicle
						Frequency	Lifetime	Power supply	Antennas	Perigee	Apogee	Period	Inclination to equator	
Sputnik I	Oct. 4, 1957, to Jan. 4, 1958	Sphere, 22.8 in. dia.	lb. 184	Aluminium alloys	Internal temperatures, pressures and "other data." Inst. container sep. from final stage.	mc. (a) 20.005 (b) 40.002	(a) and (b) stopped Oct. 27, 1957.	Chemical batteries.	4 spring-loaded whip, 7 ft. 10½ in. and 9 ft. 6 in.	miles 142	miles 588	min. 96.17	deg. 65.0	*Modified Soviet I.R.B.M.?
Sputnik II	Nov. 3, 1957, to April 14, 1958	Cone-tipped cyl., 75 ft. long (est.)	1,120 (equipment plus dog)	Aluminium alloys	Physiological reactions of test animal (dog "Laika"), cosmic rays, solar ultra-violet and X-radiation, temperatures and pressures.	(a) 20.005 (b) 40.002	(a) and (b) stopped Nov. 10, 1957.	Chemical batteries.	Not disclosed	140	1,038	103.7	65.0	*Modified Soviet I.C.B.M.?
Vanguard (TV-3)	Dec. 6, 1957, to 0	Sphere, 6.4 in.	3¼	Magnesium-aluminium-silicon-monoxide	Micrometeor impact and geodetic measurements.	(a) 108.00 at 10 mw. (b) 108.03 at 5 mw.	(a) } Not. (b) } applic.	(a) Mercury battery. (b) Six groups of solar cells.	1 turnstile, 1 dipole, with total of 6×12 in. rods.	FAILED TO ORBIT (Vehicle lost thrust at take-off; consumed in flames.)				†U.S. Navy TV-3. 3 stages, length 72 ft., launch wt. 22,600 lb. Stage 1: 44 ft. long × 45 in. dia., s.t. 28,000 lb. × 142 sec. Stage 2: 31 ft. long × 32 in. dia., s.t. 7,500 lb. Stage 3: 5 ft. long × 20 in. dia., s.t. 2,300 lb.
Explorer I	Jan. 31, 1958 (3 to 5 years est.)	Cone-tipped cyl., 6 ft. 8 in. × 6 in. dia.	30.8 (including stage four rocket case) 18.3 equipment	Steel with 8 aluminium oxide strips	Cosmic rays, micrometeors, internal temperatures, nose cone, front skin and rear skin. (Radiation belt discovered girdling equator.)	(a) 108.00 at 10 mw. (b) 108.03 at 60 mw.	(a) stopped May 23, 1958. (b) stopped Feb. 11, 1958, began again Feb. 24, stopped finally Feb. 28, 1958.	Mercury batteries.	1 turnstile with 4 whip elements 22.5 in. long, 1 dipole using skin of satellite.	224	1,573	114.8	33.34	†U.S. Army Jupiter C. 4 stages, length overall 68.6 ft. Stage 1: elongated Redstone. Stage 2: 11 scaled-down Sergeants. Stage 3: 3 scaled-down Sergeants. Stage 4: 1 scaled-down Sergeant.
Vanguard (TV-3 backup)	Feb. 5, 1958, to 0	Sphere, 6.4 in.	3¼	Magnesium-aluminium-silicon-monoxide	Micrometeor impact and geodetic measurements.	(a) 108.00 at 10 mw. (b) 108.03 at 5 mw.	(a) } Not (b) } applic.	(a) Mercury battery. (b) Six groups of solar cells.	1 turnstile, 1 dipole, with total of 6×12 in. rods.	FAILED TO ORBIT (Control system failure after 57 sec.; rocket broke in half.)				†U.S. Navy TV-3 (backup). Same as TV-3 (Dec. 6, 1957).
Explorer II	March 5, 1958, to 0	Cone-tipped cyl., 6 ft. 8 in. × 6 in. dia.	31.5 (including stage four rocket case) 18.83 equipment	Stainless steel	Cosmic rays, micrometeors.	(a) 108.03 at 60 mw. (b) 108.00 at 10 mw.	(a) } Not (b) } applic.	Mercury batteries.	2 dipole using skin of satellite itself.	FAILED TO ORBIT (Final stage did not ignite.)				†U.S. Army Jupiter C. Same as Explorer I vehicle (Jan. 31, 1958).
Vanguard I (TV-4)	March 17, 1958 (200 to 1,000 years est.)	Sphere, 6.4 in.	3¼	Magnesium-aluminium-silicon-monoxide	Temperatures and geodetic measurements.	(a) 108.00 at 10 mw. (b) 108.03 at 5 mw.	(a) stopped April 5, 1958. (b) Indefinitely.	(a) Mercury battery. (b) Six groups of solar cells.	1 turnstile, 1 dipole, with total of 6×12 in. rods.	409	2,453	134.18	34.3	†U.S. Navy Vanguard I. Same as TV-3.
Explorer III	March 26, 1958, to June 27, 1958	Cone-tipped cyl., 6 ft. 8 in. × 6 in. dia.	31 (including stage four rocket case) 18.56 equipment	Steel with 8 aluminium oxide strips	Cosmic rays (with tape recorder), micrometeors, internal and external temperatures.	(a) 108.00 at 10 mw. (b) 108.03 at 60 mw.	(a) Telemetering and beacon signal stopped May 10, 1958; beacon transmitted again May 15 to June 16. (b) First stopped May 14; responded erratically May 22 to June 5, 1958.	Mercury batteries.	2 dipole, using skin of satellite itself.	121	1,746	115.87	33.4	†U.S. Army Jupiter C. Same as Explorer I.
Vanguard (TV-5)	April 28, 1958, to 0	Sphere, 20 in. dia.	21.5	Highly polished silicon-monoxide-coated magnesium	Solar X-radiation and space environment.	(a) 108.00 at 80 mw. (tracking and telemetry)	Not applicable	Mercury batteries.	4 spring-lock rods.	FAILED TO ORBIT (Final stage did not ignite.)				†U.S. Navy Vanguard. Same as TV-3.
Sputnik III	May 15, 1958 (17 months est.)	Cone, 11 ft. 9 in. × 5 ft. 8 in. (over base)	2,925	Aluminium alloys	Atmospheric pressure and composition, concentration of positive ions, satellite's electrical charge, Earth's magnetic field, intensity of Sun's corpuscular radiation, composition and	(a) 20.005 (transmission at 40.01 is harmonic of 1st)	(a) Indefinitely.	(a) Chemical batteries. Solar cells.	Folded dipole and trailing rods.	135	1,167	106.0	65.3	*Modified Soviet I.C.B.M.?

	(17 min. 6 e.t.)	5 ft. 8 in. (over base)			charge, Earth's magnetic field, intensity of Sun's corpuscular radiation, composition and variations of primary cosmic rays, micrometeors, temperature measurements.	at 40.01 is harmonic of 1st)			Solar cells.	rods.				
Vanguard (SLV–1)	May 27, 1958, to 0	Sphere, 20 in. dia.	21.5	Highly polished silicon-monoxide-coated magnesium	Solar Lyman-Alpha radiation and space environment.	(a) 108.00 at 80 mw. continuous (tracking and telemetry)	Not applicable.	Mercury batteries	4 spring-lock rods.	FA'LED TO ORBIT (2nd stage did not cut off properly, causing injection of final stage at wrong angle.)				†U.S. Navy Vanguard SLV–1. Same as TV–3.
Vanguard .. (SLV–2)	June 26, 1958, to 0	Sphere 20 in. dia.	21.5	Highly polished silicon-monoxide-coated magnesium	Solar x-rays	(a) 108.00 at 80 mw. continuously (tracking and telemetry)	Not applic.	Mercury batteries	4 spring-lock rods	FAILED TO ORBIT (2nd stage engine cut off early.)				†U.S. Navy Vanguard SLV–2. Same as TV–3.
Explorer IV ..	July 26, 1958/ 1 year plus est.	Cone-tipped cyl. 6 ft. 8 in. × 6.25 in. dia.	38.4 (including stage four rocket case) 25.8 equipment	Stainless steel	Corpuscular radiation at several intensity levels. (The sub-carrier oscillator was calibrated to give internal temperature measurements.)	(a) 108.00 at 10 mw. (a) 108.03 at 24 mw.	(a) stopped Sept. 9, 1958 (b stopped Oct. 6, 1958 (last intelligible telemetry Sept. 19, 1958)	Mercury batteries	2 dipole using skin of satellite itself	163	1,380	110. 7	50.29	†U.S. Army Jupiter C. Same as Explorer I.
Unnamed .. (First attempted Moon probe)	August 17, 1958, to 0	Toroidal 30 in. × 29 in. dia.	83.8 (including shell and retro-rocket) 25.0 equipment	Glassfibre	Radiation in space; magnetic fields of Earth and Moon; density of micrometeors; internal temperatures; electronic scanner.	(a) 108.6 at 300 mw. (telemetry and doppler command) (b) 108.09 at 1 watt.	Designed to last 10 days	Mercury batteries	2×12 in. metal rods	FAILED IN MISSION (Exploded after 77 sec.; reached alt. of 40,000–70,000 ft.)				†U.S.A.F. Thor-Able 4 stages, length overall 88.1 ft., launch wt. 112,000 lb. Stage 1: Thor I.R.B.M. Stage 2: Modified Vanguard second stage. Stage 3: Vanguard third stage (ABL.X2). Stage 4: Thiokol solid (retro) rocket, intended to orbit probe around moon.
Explorer V ..	August 24, 1958, to 0	Cone-tipped cyl. 6 ft. 8 in. × 6 in. dia.	38.43 (including stage four rocket case) 25.8 equipment	Stainless steel	Corpuscular radiation at several intensity levels.	(a) 108.03 at 30 mw. (b) 108.00 at 10 mw.	(a) (b) Not applic	Mercury batteries	2 dipole using skin of satellite itself	FAILED TO ORBIT (Collision between separated 1st stage and control compartment carrying 3 high-speed stages.)				†U.S. Army Jupiter C. Same as Explorer I.
Vanguard .. (SLV–3)	Sept. 26, 1958, to 0	Sphere 20 in. dia.	21.5	Highly polished silicon-monoxide-coated magnesium	Earth's cloud cover (fitted with two infra-red photocells).	(a) 108.00 at 10 mw. (b) 108.03 at 1 watt.	(a) (b) Not applic.	Mercury batteries	1 turnstile with four 30-in. spring-loaded rods	FAILED TO ORBIT (2nd stage gave inadequate speed; satellite believed to have made one circuit.)				†U.S. Navy Vanguard SLV–3. Same as TV–3.
Pioneer I .. (Moon probe)	Oct. 11, 1958/ Oct. 12, 1958 (43 hr. 17.5 min.)	Toroidal 30 in. × 29 in. dia.	84.4 (including 43.7 lb. of vernier and retro-rockets) 39 instruments	Glassfibre	Radiation in space; magnetic fields of Earth and Moon; density of micrometeors; internal temperature;; electronic scanner. (Determined radial extent of radiation belt.)	(a) 108.06 at 300 mw. (telemetry and doppler command) (b) 108.09 at 1 watt. (controls)	Designed to last 10 days	Mercury batteries	2×12 in. metal rods	FAILED IN MISSION (Lacked sufficient speed.) 70,700 (max. distance)				†U.S.A.F. Thor-Able 1 4 stages (same as unnamed Moon-probe August 17).
Beacon .. .. (Inflatable satellite)	Oct. 23, 1958, to 0	Cone-tipped cyl. (containing folded sphere) 50 in. × 7 in. dia.	31.5 (including stage four rocket case) inflatable satellite 9.26	Mylar polyester film and micro-thin aluminium foil	Atmospheric density at various levels by studying behaviour of 12 ft. inflated sphere over estimated lifetime of two weeks.		INFLATABLE SATELLITE CARRIED NO TRANSMITTER (tracking transmitter in final stage)			FAILED TO ORBIT (Part of high-speed cluster separated from booster before cut-off.)				†U.S. Army Jupiter C. Same as Explorer I.
Pioneer II .. (Moon probe)	Nov. 8, 1958, to 0 (42.4 min.)	Toroidal 30 in. × 29 in. dia.	86.4 (total) 34.3 instruments	Glassfibre	Total ionizing radiation; cosmic ray flux; magnetic fields of Earth and Moon; density of micrometeors; internal temperatures; electronic scanner.	a) 108.06 at 300 mw. (telemetry and doppler command) (b) 108.09 at 100 mw. (telemetry)	Designed to last 10 days	Mercury batteries	2×12 in. metal rods	FAILED IN MISSION (3rd stage failed to ignite.) 963 (max. distance)				†U.S.A.F. Thor-Able 1. 4 stages (same as unnamed Moon-probe August 17).
Pioneer III .. (Space probe)	Dec. 6, 1958/ Dec. 7, 1958 (38 hr. 6 min.)	Cone 23 in. × 10 in. dia. (max.)	12.95	Gold-washed glassfibre	Radiation in space. (Discovery of second, outer radiation belt girdling equator.) Vehicle intended to pass Moon and become satellite of Sun.	960.05 at 180 mw.	90-hr. (design limit)	Mercury batteries	Cone itself serves as antenna; gold is conductor	FAILED IN MISSION (Lacked sufficient speed.) 63,580 (max. distance)				†U.S. Army Juno II. 4 stages, length 76 ft., launch wt. 121,000 lb. Stage 1: Jupiter I.R.B.M. (modified). Stage 2: 11 scaled-down Sergeants. Stage 3: 3 scaled-down Sergeants. Stage 4: 1 scaled-down Sergeant.
Project Score ..	Dec. 18, 1958/ Jan. 21, 1959	Cone-tipped cyl. 85 ft. × 10 ft. dia.	8,750 (total) 150 (radio equipment)	Stainless steel	Radio-communications (fitted with twin packages of trans., recording and receiving equip., wt. 35 lb. each. Other components: battery, voltage converter, radio beacon, control unit.) First speech transmission (by Pres. Eisenhower), via satellite.	(a) 132.435 and 132.905 F.M. (b) 107.97 and 107.94 Minitrack	12 days	Mercury batteries	Slot-type, flush with body of Atlas	110	920	101.46	32.3	†U.S.A.F. WS107A–1 Atlas. 1½ stages, length overall 85 ft., launch wt. 244,000 approx. Booster: 2×150,000 lb. s.t. engines in jettisonable skirt. Sustainer: 1×60,000 lb. s.t. engine.
Mechta .. .. (or Lunik)	Jan. 2, 1959 in orbit around Sun	Sphere (inst. container separated from final stage)	3,245 (total, incl. final stage) 800 (instrument container)	Aluminium magnesium alloy	Internal and external temperatures; gas components of interplanetary matter and corpuscular radiation of Sun; magnetic fields of Earth and Moon; micrometeors, heavy nuclei in primary cosmic rays, and other properties. Ejection of sodium vapour cloud from final stage. Vehicle passed within 3.125 to 4,375 miles of Moon.	(a) 19.997 and 19.995 signals of 1.6 sec. duration; (b) 19.993 signals of 50.9 sec. duration (c) 183.6		Silver zinc and mercury oxide batteries	(a) 4 metal rods (b) 2 'T' antennas (c) 1 'T' antenna	91.2 million (perihelion)	123.1 million (aphelion)	450 days		*Modified Soviet I.C.B.M.? Three or four stages, final stage 20 ft. long ×10 ft. dia.
										SUN SATELLITE				
Vanguard II .. (SLV–4)	Feb. 17, 1959 (10 years plus est.)	Sphere, 20 in. dia.	20.74	Highly polished silicon-monoxide-coated magnesium	Earth's cloud cover (carried two infra-red photocells). Satellite developed wobbling motion, rendering interpretation of data impossible.	(a) 108.00 at 10 mw. (b) 108.03 at 80 mw. (triggered from ground)	(a) 23 days (b) 27 days	Mercury batteries	4 spring-lock rods	347	2,064	125.85	32.88	†U.S. Navy Vanguard. Same as TV–3.
Pioneer IV .. (space-probe)	March 3, 1959 in orbit around Sun	Cone, 20 in. ×9 in. dia.	13.40	Gold-washed glassfibre	Radiation in space; test of photo-electric sensor (for triggering of future Moon-probe cameras) if within 20,000 miles of Moon. Produced excellent radiation data; probe passed within 37,300 miles of Moon; sensor not operated	960.05 at 180 mw. with three sub-carriers	90 hr. (approx.)	Mercury batteries	Cone itself serves as antenna; gold is conductor	91.7 million (perihelion)	106.1 million (aphelion)	443 days	—	†U.S. Army Juno II. Same as Pioneer III.
										SUN SATELLITE				

Vanguard (TV–3)	Dec. 6, 1957, to 0	Sphere, 6.4 in.	3¼	Magnesium-aluminium-silicon-monoxide	Micrometeor impact and geodetic measurements.	(a) 108.00 at 10 mw. (b) 108.03 at 5 mw.	(a) } Not. (b) } applic.	(a) Mercury battery. (b) Six groups of solar cells.	1 turnstile, 1 dipole, with total of 6×12 in. rods.	FAILED TO ORBIT (Vehicle lost thrust at take-off; consumed in flames.)				†U.S. Navy TV–3. 3 stages, length 72 ft., launch wt. 22,600 lb. Stage 1: 44 ft. long × 45 in. dia., s.t. 28,000 lb. × 142 sec. Stage 2: 31 ft. long × 32 in. dia., s.t. 7,500 lb. Stage 3: 5 ft. long × 20 in. dia., s.t. 2,300 lb.
Explorer I	Jan. 31, 1958 (3 to 5 years est.)	Cone-tipped cyl., 6 ft. 8 in. × 6 in. dia.	30.8 (including stage four rocket case) 18.3 equipment	Steel with 8 aluminium oxide strips	Cosmic rays, micrometeors, internal temperatures, nose cone, front skin and rear skin. (Radiation belt discovered girdling equator.)	(a) 108.00 at 10 mw. (b) 108.03 at 60 mw.	(a) stopped May 23, 1958. (b) stopped Feb. 11, 1958, began again Feb. 24, stopped finally Feb. 28, 1958.	Mercury batteries.	1 turnstile with 4 whip elements 22.5 in. long, 1 dipole using skin of satellite.	224	1,573	114.8	33.34	†U.S. Army Jupiter C. 4 stages, length overall 68.6 ft. Stage 1: elongated Redstone. Stage 2: 11 scaled-down Sergeants. Stage 3: 3 scaled-down Sergeants. Stage 4: 1 scaled-down Sergeant.
Vanguard (TV–3 backup)	Feb. 5, 1958, to 0	Sphere, 6.4 in.	3¼	Magnesium-aluminium-silicon-monoxide	Micrometeor impact and geodetic measurements.	(a) 108.00 at 10 mw. (b) 108.03 at 5 mw.	(a) } Not (b) } applic.	(a) Mercury battery. (b) Six groups of solar cells.	1 turnstile, 1 dipole, with total of 6×12 in. rods.	FAILED TO ORBIT (Control system failure after 57 sec.; rocket broke in half.)				†U.S. Navy TV–3 (backup). Same as TV–3 (Dec. 6, 1957).
Explorer II	March 5, 1958, to 0	Cone-tipped cyl., 6 ft. 8 in. × 6 in. dia.	31.5 (including stage four rocket case) 18.83 equipment	Stainless steel	Cosmic rays, micrometeors.	(a) 108.03 at 60 mw. (b) 108.00 at 10 mw.	(a) } Not (b) } applic.	Mercury batteries.	2 dipole using skin of satellite itself.	FAILED TO ORBIT (Final stage did not ignite.)				†U.S. Army Jupiter C. Same as Explorer I vehicle (Jan. 31, 1958).
Vanguard I (TV–4)	March 17, 1958 (200 to 1,000 years est.)	Sphere, 6.4 in.	3¼	Magnesium-aluminium-silicon-monoxide	Temperatures and geodetic measurements.	(a) 108.00 at 10 mw. (b) 108.03 at 5 mw.	(a) stopped April 5, 1958. (b) Indefinitely.	(a) Mercury battery. (b) Six groups of solar cells.	1 turnstile, 1 dipole, with total of 6×12 in. rods.	409	2,453	134.18	34.3	†U.S. Navy Vanguard I. Same as TV–3.
Explorer III	March 26, 1958, to June 27, 1958	Cone-tipped cyl., 6 ft. 8 in. × 6 in. dia.	31 (including stage four rocket case) 18.56 equipment	Steel with 8 aluminium oxide strips	Cosmic rays (with tape recorder), micrometeors, internal and external temperatures.	(a) 108.00 at 10 mw. (b) 108.03 at 60 mw.	(a) Telemetering and beacon signal stopped May 10, 1958; beacon transmitted again May 15 to June 16. (b) First stopped May 14; responded erratically May 22 to June 5, 1958.	Mercury batteries.	2 dipole, using skin of satellite itself.	121	1,746	115.87	33.4	†U.S. Army Jupiter C. Same as Explorer I.
Vanguard (TV–5)	April 28, 1958, to 0	Sphere, 20 in. dia.	21.5	Highly polished silicon-monoxide-coated magnesium	Solar X-radiation and space environment.	(a) 108.00 at 80 mw. (tracking and telemetry)	Not applicable	Mercury batteries.	4 spring-lock rods.	FAILED TO ORBIT (Final stage did not ignite.)				†U.S. Navy Vanguard. Same as TV–3.
Sputnik III	May 15, 1958 (17 months est.)	Cone, 11 ft. 9 in. × 5 ft. 8 in. (over base)	2,925	Aluminium alloys	Atmospheric pressure and composition, concentration of positive ions, satellite's electrical charge, Earth's magnetic field, intensity of Sun's corpuscular radiation, composition and variations of primary cosmic rays, micrometeors, temperature measurements.	(a) 20.005 (transmission at 40.01 is harmonic of 1st)	(a) Indefinitely.	(a) Chemical batteries. Solar cells.	Folded dipole and trailing rods.	135	1,167	106.0	65.3	*Modified Soviet I.C.B.M.?
Vanguard (SLV–1)	May 27, 1958, to 0	Sphere, 20 in. dia.	21.5	Highly polished silicon-monoxide-coated magnesium	Solar Lyman-Alpha radiation and space environment.	(a) 108.00 at 80 mw. continuous (tracking and telemetry)	Not applicable.	Mercury batteries	4 spring-lock rods.	FAILED TO ORBIT (2nd stage did not cut off properly, causing injection of final stage at wrong angle.)				†U.S. Navy Vanguard SLV–1. Same as TV–3.
Vanguard .. (SLV–2)	June 26, 1958, to 0	Sphere 20 in. dia.	21.5	Highly polished silicon-monoxide-coated magnesium	Solar x-rays	(a) 108.00 at 80 mw. continuously (tracking and telemetry)	Not applic.	Mercury batteries	4 spring-lock rods	FAILED TO ORBIT (2nd stage engine cut off early.)				†U.S. Navy Vanguard SLV–2. Same as TV–3.
Explorer IV ..	July 26, 1958/ 1 year plus est.	Cone-tipped cyl. 6 ft. 8 in. × 6.25 in. dia.	38.4 (including stage four rocket case) 25.8 equipment	Stainless steel	Corpuscular radiation at several intensity levels. (The subcarrier oscillator was calibrated to give internal temperature measurements.)	(a) 108.00 at 10 mw. (a) 108.03 at 24 mw.	(a) stopped Sept. 9, 1958 (b) stopped Oct. 6, 1958 (last intelligible telemetry Sept. 19, 1958)	Mercury batteries	2 dipole using skin of satellite itself	163	1,380	110.7	50.29	†U.S. Army Jupiter C. Same as Explorer I.
Unnamed .. (First attempted Moon probe)	August 17, 1958, to 0	Toroidal 30 in. × 29 in. dia.	83.8 (including shell and retro-rocket) 25.0 equipment	Glassfibre	Radiation in space; magnetic fields of Earth and Moon; density of micrometeors; internal temperatures; electronic scanner.	(a) 108.6 at 300 mw. (telemetry and doppler command) (b) 108.09 at 1 watt.	Designed to last 10 days	Mercury batteries	2×12 in. metal rods	FAILED IN MISSION (Exploded after 77 sec.; reached alt. of 40,000–70,000 ft.)				†U.S.A.F. Thor-Able 4 stages, length overall 88.1 ft., launch wt. 112,000 lb. Stage 1: Thor I.R.B.M. Stage 2: Modified Vanguard second stage. Stage 3: Vanguard third stage (ABL.X2). Stage 4: Thiokol solid (retro) rocket, intended to orbit probe around moon.
Explorer V ..	August 24, 1958, to 0	Cone-tipped cyl. 6 ft. 8 in. × 6 in. dia.	38.43 (including stage four rocket case) 25.8 equipment	Stainless steel	Corpuscular radiation at several intensity levels.	(a) 108.03 at 30 mw. (b) 108.00 at 10 mw.	(a) } Not (b) } applic	Mercury batteries	2 dipole using skin of satellite itself	FAILED TO ORBIT (Collision between separated 1st stage and control compartment carrying 3 high-speed stages.)				†U.S. Army Jupiter C. Same as Explorer I.
Vanguard .. (SLV–3)	Sept. 26, 1958, to 0	Sphere 20 in. dia.	21.5	Highly polished silicon-monoxide-coated magnesium	Earth's cloud cover (fitted with two infra-red photocells).	(a) 108.00 at 10 mw. (b) 108.03 at 1 watt.	(a) } Not (b) } applic.	Mercury batteries	1 turnstile with four 30-in. spring-loaded rods	FAILED TO ORBIT (2nd stage gave inadequate speed; satellite believed to have made one circuit.)				†U.S. Navy Vanguard SLV–3. Same as TV–3.
Pioneer I .. (Moon probe)	Oct. 11, 1958/ Oct. 12, 1958 (43 hr. 17.5 min.)	Toroidal 30 in. × 29 in. dia.	84.4 (including 43.7 lb. of vernier and retro-rockets) 39 instruments	Glassfibre	Radiation in space; magnetic fields of Earth and Moon; density of micrometeors; internal temperatures; electronic scanner. (Determined radial extent of radiation belt.)	(a) 108.06 at 300 mw. (telemetry and doppler command) (b) 108.09 at 1 watt. (controls)	Designed to last 10 days	Mercury batteries	2×12 in. metal rods	FAILED IN MISSION (Lacked sufficient speed.) 70,700 (max. distance)				†U.S.A.F. Thor-Able 1 4 stages (same as unnamed Moon-probe August 17).
Beacon	Oct. 23,	Cone-tipped	31.5	Mylar poly-	Atmospheric density at various	INFLATABLE SATELLITE				FAILED TO ORBIT				†U.S. Army Jupiter C.

						(controls)							
Beacon .. .. (Inflatable satellite)	Oct. 23, 1958, to 0	Cone-tipped cyl. (containing folded sphere) 50 in. × 7 in. dia.	31.5 (including stage four rocket case) inflatable satellite 9.26	Mylar polyester film and microthin aluminium foil	Atmospheric density at various levels by studying behaviour of 12 ft. inflated sphere over estimated lifetime of two weeks.		INFLATABLE SATELLITE CARRIED NO TRANSMITTER (tracking transmitter in final stage)			FAILED TO ORBIT (Part of high-speed cluster separated from booster before cut-off.)			†U.S. Army Jupiter C. Same as Explorer I.
Pioneer II .. (Moon probe)	Nov. 8, 1958, to 0 (42.4 min.)	Toroidal 30 in. × 29 in. dia.	86.4 (total) 34.3 instruments	Glassfibre	Total ionizing radiation; cosmic ray flux; magnetic fields of Earth and Moon; density of micrometeors; internal temperatures; electronic scanner.	a) 108.06 at 300 mw. (telemetry and doppler command) (b) 108.09 at 100 mw. (telemetry)	Designed to last 10 days	Mercury batteries	2×12 in. metal rods	FAILED IN MISSION (3rd stage failed to ignite.) 963 (max. distance)			†U.S.A.F. Thor-Able 1. 4 stages (same as unnamed Moon-probe August 17).
Pioneer III .. (Space probe)	Dec. 6, 1958/ Dec. 7, 1958 (38 hr. 6 min.)	Cone 23 in. × 10 in. dia. (max.)	12.95	Gold-washed glassfibre	Radiation in space. (Discovery of second, outer radiation belt girdling equator.) Vehicle intended to pass Moon and become satellite of Sun.	960.05 at 180 mw.	90-hr. (design limit)	Mercury batteries	Cone itself serves as antenna; gold is conductor	FAILED IN MISSION (Lacked sufficient speed.) 63,580 (max. distance)			†U.S. Army Juno II. 4 stages, length 76 ft., launch wt. 121,000 lb. Stage 1: Jupiter I.R.B.M. (modified). Stage 2: 11 scaled-down Sergeants. Stage 3: 3 scaled-down Sergeants. Stage 4: 1 scaled-down Sergeant.
Project Score ..	Dec. 18, 1958/ Jan. 21, 1959	Cone-tipped cyl. 85 ft. × 10 ft. dia.	8,750 (total) 150 (radio equipment)	Stainless steel	Radio-communications (fitted with twin packages of trans., recording and receiving equip., wt. 35 lb. each. Other components: battery, voltage converter, radio beacon, control unit.) First speech transmission (by Pres. Eisenhower), via satellite.	(a) 132.435 and 132.905 F.M. (b) 107.97 and 107.94 Minitrack	12 days	Mercury batteries	Slot-type, flush with body of Atlas	110	920	101.46	32.3	†U.S.A.F. WS107A–1 Atlas. 1½ stages, length overall 85 ft., launch wt. 244,000 approx. Booster: 2×150,000 lb. s.t. engines in jettisonable skirt. Sustainer: 1×60,000 lb. s.t. engine.
Mechta .. .. (or Lunik)	Jan. 2, 1959 in orbit around Sun	Sphere (inst. container separated from final stage)	3,245 (total, incl. final stage) 800 (instrument container)	Aluminium magnesium alloy	Internal and external temperatures; gas components of interplanetary matter and corpuscular radiation of Sun; magnetic fields of Earth and Moon; micrometeors, heavy nuclei in primary cosmic rays, and other properties. Ejection of sodium vapour cloud from final stage. Vehicle passed within 3,125 to 4,375 miles of Moon.	(a) 19.997 and 19.995 signals of 1.6 sec. duration; (b) 19.993 signals of 50.9 sec. duration (c) 183.6		Silver zinc and mercury oxide batteries	(a) 4 metal rods (b) 2 'T' antennas (c) 1 'T' antenna	91.2 million (perihelion)	123.1 million (aphelion)	450 days		*Modified Soviet I.C.B.M.? Three or four stages, final stage 20 ft. long ×10 ft. dia.
										SUN SATELLITE				
Vanguard II .. (SLV–4)	Feb. 17, 1959 (10 years plus est.)	Sphere, 20 in. dia.	20.74	Highly polished silicon-monoxide-coated magnesium	Earth's cloud cover (carried two infra-red photocells). Satellite developed wobbling motion, rendering interpretation of data impossible.	(a) 108.00 at 10 mw. (b) 108.03 at 80 mw. (triggered from ground)	(a) 23 days (b) 27 days	Mercury batteries	4 spring-lock rods	347	2,064	125.85	32.88	†U.S. Navy Vanguard. Same as TV–3.
Pioneer IV .. (space-probe)	March 3, 1959 in orbit around Sun	Cone, 20 in. ×9 in. dia.	13.40	Gold-washed glassfibre	Radiation in space; test of photo-electric sensor (for triggering of future Moon-probe cameras) if within 20,000 miles of Moon. Produced excellent radiation data; probe passed within 37,300 miles of Moon; sensor not operated.	960.05 at 180 mw. with three sub-carriers	90 hr. (approx.)	Mercury batteries	Cone itself serves as antenna; gold is conductor	91.7 million (perihelion)	106.1 million (aphelion)	443 days	—	†U.S. Army Juno II. Same as Pioneer III.
										SUN SATELLITE				
Discoverer I ..	Feb. 28, 1959, to March 5, 1959	Cone-tipped cyl., 18.8 ft. × 5 ft. dia.	1,300 (total, including final stage) 245 (instruments)	Not disclosed	Tests of propulsion, guidance, staging and communications. First polar orbit. Radio transmitter failed—only intermittent signals received.	Not disclosed	Not disclosed	Nickel cadmium batteries	1 directional, 1 whip	99	605	95.9	3 deg. off Earth's north-south axis	‡U.S.A.F. Thor-Hustler, 2 stages, length overall 78.2 ft., launch wt. 108,500 lb. (approx.). Stage 1: Thor I.R.B.M., launch wt. 100,000 lb. plus; 150,000 lb. s.t. Stage 2: Hustler, launch wt. 8,400 lb., 15,000 lb. s.t.
Discoverer II ..	April 13, 1959, to April 26	Cone-tipped cyl., 19.2 ft. × 5 ft. dia.	1,610 (total, including final stage) 245 (instruments)	Not disclosed	Recovery of 195-lb. hemisphere-shaped capsule 27 in. long × 33-in. base dia. Also to maintain in capsule temperatures and oxygen sufficient to sustain life; radiation in space (emulsion packs). Timer ejected capsule on April 14, but not recovered.	Not disclosed	Not disclosed	Nickel cadmium batteries	1 directional, 1 whip	142	220	90.5	.2 deg. off Earth's north-south axis	‡U.S.A.F. Thor-Hustler Same as for Discoverer I, but overall length 78.6 ft.
Vanguard .. (SLV–5)	April 13, 1959, to 0	Sphere, (a) 13 in. dia. with 17.5 in. × 2.5 in. dia. cyl. extension (b) Sphere (inflatable) 30.0 in. dia.	23.3 (total, two scientific payloads)	(a) Glassfibre and phenolic resins (b) Laminated aluminium foil and plastic sheet	Mapping of Earth's magnetic field by magnetometer; drag studies in outer atmosphere.	(a) 108.00 at 10 mw. (tracking) and 108.03 at 80 mw. (telemetry on ground command)	(a Not applicable	Silver zinc batteries	4 spring-lock rods	FAILED TO ORBIT (2nd stage failure caused tumbling motion.)				†U.S. Navy Vanguard. Same as TV–3.

RECORD OF ALL KNOWN SPACE-VEHICLE LAUNCHES

Corrected to August 13, 1959

Name	Lifetime	Shape and size	Weight	Shell material	Experiments	Radio				Orbit				Launching site and vehicle
						Frequency	Lifetime	Power supply	Antennas	Perigee	Apogee	Period	Inclination to equator	
Sputnik I	Oct. 4, 1957, to Jan. 4, 1958	Sphere, 22.8 in. dia.	lb. 184	Aluminium alloys	Internal temperatures, pressures and "other data." Inst. container sep. from final stage.	mc. (a) 20.005 (b) 40.002	(a) and (b) stopped Oct. 27, 1957.	Chemical batteries.	4 spring-loaded whip, 7 ft. 10½ in. and 9 ft. 6 in.	miles 142	miles 588	min. 96.17	deg. 65.0	*Modified Soviet I.R.B.M.?
Sputnik II	Nov. 3, 1957, to April 14, 1958	Cone-tipped cyl., 75 ft. long (est.)	1,120 (equipment plus dog)	Aluminium alloys	Physiological reactions of test animal (dog "Laika"), cosmic rays, solar ultra-violet and X-radiation, temperatures and pressures.	(a) 20.005 (b) 40.002	(a) and (b) stopped Nov. 10, 1957.	Chemical batteries.	Not disclosed	140	1,038	103.7	65.0	*Modified Soviet I.C.B.M.?
Vanguard (TV–3)	Dec. 6, 1957, to 0	Sphere, 6.4 in.	3½	Magnesium-aluminium-silicon-monoxide	Micrometeor impact and geodetic measurements.	(a) 108.00 at 10 mw. (b) 108.03 at 5 mw.	(a) } Not. (b) } applic.	(a) Mercury battery. (b) Six groups of solar cells.	1 turnstile, 1 dipole, with total of 6×12 in. rods.	FAILED TO ORBIT (Vehicle lost thrust at take-off; consumed in flames.)				†U.S. Navy TV–3. 3 stages, length 72 ft., launch wt. 22,600 lb. Stage 1: 44 ft. long × 45 in. dia., s.t. 28,000 lb. × 142 sec. Stage 2: 31 ft. long × 32 in. dia., s.t. 7,500 lb. Stage 3: 5 ft. long × 20 in. dia., s.t. 2,300 lb.
Explorer I	Jan. 31, 1958 (3 to 5 years est.)	Cone-tipped cyl., 6 ft. 8 in. × 6 in. dia.	30.8 (including stage four rocket case) 18.3 equipment	Steel with 8 aluminium oxide strips	Cosmic rays, micrometeors, internal temperatures, nose cone, front skin and rear skin. (Radiation belt discovered girdling equator.)	(a) 108.00 at 10 mw. (b) 108.03 at 60 mw.	(a) stopped May 23, 1958. (b) stopped Feb. 11, 1958, began again Feb. 24, stopped finally Feb. 28, 1958.	Mercury batteries.	1 turnstile with 4 whip elements 22.5 in. long, 1 dipole using skin of satellite.	224	1,573	114.8	33.34	†U.S. Army Jupiter C. 4 stages, length overall 68.6 ft. Stage 1: elongated Redstone. Stage 2: 11 scaled-down Sergeants. Stage 3: 3 scaled-down Sergeants. Stage 4: 1 scaled-down Sergeant.
Vanguard (TV–3 backup)	Feb. 5, 1958, to 0	Sphere, 6.4 in.	3½	Magnesium-aluminium-silicon-monoxide	Micrometeor impact and geodetic measurements.	(a) 108.00 at 10 mw. (b) 108.03 at 5 mw.	(a) } Not (b) } applic.	(a) Mercury battery. (b) Six groups of solar cells.	1 turnstile, 1 dipole, with total of 6×12 in. rods.	FAILED TO ORBIT (Control system failure after 57 sec.; rocket broke in half.)				†U.S. Navy TV–3 (backup). Same as TV–3 (Dec. 6, 1957).
Explorer II	March 5, 1958, to 0	Cone-tipped cyl., 6 ft. 8 in. × 6 in. dia.	31.5 (including stage four rocket case) 18.83 equipment	Stainless steel	Cosmic rays, micrometeors.	(a) 108.03 at 60 mw. (b) 108.00 at 10 mw.	(a) } Not (b) } applic.	Mercury batteries.	2 dipole using skin of satellite itself.	FAILED TO ORBIT (Final stage did not ignite.)				†U.S. Army Jupiter C. Same as Explorer I vehicle (Jan. 31, 1958).
Vanguard I (TV–4)	March 17, 1958 (200 to 1,000 years est.)	Sphere, 6.4 in.	3½	Magnesium-aluminium-silicon-monoxide	Temperatures and geodetic measurements.	(a) 108.00 at 10 mw. (b) 108.03 at 5 mw.	(a) stopped April 5, 1958. (b) Indefinitely.	(a) Mercury battery. (b) Six groups of solar cells.	1 turnstile, 1 dipole, with total of 6×12 in. rods.	409	2,453	134.18	34.3	†U.S. Navy Vanguard I. Same as TV–3.
Explorer III	March 26, 1958, to June 27, 1958	Cone-tipped cyl., 6 ft. 8 in. × 6 in. dia.	31 (including stage four rocket case) 18.56 equipment	Steel with 8 aluminium oxide strips	Cosmic rays (with tape recorder), micrometeors, internal and external temperatures.	(a) 108.00 at 10 mw. (b) 108.03 at 60 mw.	(a) Telemetering and beacon signal stopped May 10, 1958; beacon transmitted again May 15 to June 16. (b) First stopped May 14; responded erratically May 22 [illegible]	Mercury batteries.	2 dipole, using skin of satellite itself.	121	1,746	115.87	33.4	†U.S. Army Jupiter C. Same as Explorer I.
Vanguard .. (SLV–5)	April 13, 1959, to 0	Sphere, (a) 13 in. dia. with 17.5 in. × 2.5 in. dia. cyl. extension (b) Sphere (inflatable) 30.0 in. dia.	23.3 (total, two scientific payloads)	(a) Glassfibre and phenolic resins (b) Laminated aluminium foil and plastic sheet	but not recovered. Mapping of Earth's magnetic field by magnetometer; drag studies in outer atmosphere.	(a) 108.00 at 10 mw. (tracking) and 108.03 at 80 mw. (telemetry on ground command)	(a Not applicable	Silver zinc batteries	4 spring-lock rods	FAILED TO ORBIT (2nd stage failure caused tumbling motion.)				†U.S. Navy Vanguard. Same as TV–3.

Discoverer III	June 3, 1959, to 0	Cone-tipped cyl., 19.2 ft. × 5 ft. dia.	1,600 (total, including final stage) 245 (instruments)	Not disclosed	Biological; four black mice in recoverable capsule.	Not disclosed	Not applicable	Nickel cadmium batteries	1 directional, 1 whip	FAILED TO ORBIT (2nd stage failure.)				‡U.S.A.F. Thor-Hustler. Same as for Discoverer II.
Vanguard (SLV-6)	June 22, 1959, to 0	Sphere, 20 in. dia.	21.5	Highly polished silicon-monoxide-coated magnesium	Earth's cloud cover (two infra-red photocells).	(a) 108.00 at 10 mw. (b) 108.03 at 80 mw. (triggered from ground)	(a) } Not (b) } applic.	Mercury batteries	4 spring-lock rods	FAILED TO ORBIT (2nd stage failure.)				†U.S. Navy Vanguard. Same as TV-3.
Discoverer IV	June 25, 1959, to 0	Cone-tipped cyl., 19.2 ft. × 5 ft. dia.	1,600 (total, including final stage) 245 (instruments)	Not disclosed	Test of capsule separation and recovery.	Not disclosed	Not disclosed	Nickel cadmium batteries	1 directional 1 whip	FAILED TO ORBIT (2nd stage failure.)				‡U.S.A.F. Thor-Hustler. Same as for Discoverer II.
Explorer VI (U.S. Army)	July 16, 1959, to 0	Toroidal, 30 in. × 30 in. dia.	91.5	Not disclosed	Seven concurrent experiments. Solar X-rays, Lyman-Alpha radiation, cosmic rays, heavy nuclei, micrometeors, radiation and heat balance.	(a) 108.00 (b) 20.000	(a) } Not (b) } applic.	Chemical batteries recharged by solar cells	(a) 4 whip (b) 4 extensible rods	FAILED TO ORBIT (Control failure immediately after take-off.)				†U.S. Army Juno II. Same as for Pioneer III.
Explorer VI (U.S.A.F.)	Aug. 7, 1959 (1 year plus est.)	Spheroid, 26 in. dia. × 29 in. deep with 4 × 20 in. square vane extensions	142.0	Aluminium	Fifteen concurrent experiments, including behaviour of radio waves in ionosphere, mapping of Earth's magnetic field, micrometeors, Earth's cloud cover, checks on various "deep space" equipment.	(a) 108.06 (b) 108.09 (c) Not disclosed (kicker rocket)	Indefinitely	Chemical batteries recharged by solar cells	Not disclosed	157	26,380	750.0	48.0	†U.S.A.F. Thor-Able. 3 stages, length overall 90 ft., launch wt. 105,000 lb. plus. Stage 1: Thor I.R.B.M. 150,000 lb. s.t. Stage 2: Modified Vanguard second stage. Stage 3: Vanguard third stage (A.B.L. X2). Stage 4: Solid "kicker" rocket on satellite axis, 14-in. long, wt. 5 lb.
Discoverer V	Aug. 13, 1959 (2 months est.)	Cone-tipped cyl., 19 ft. × 5 ft. dia. capsule 27 in. × 33 in. dia.	1,700 (total, including final stage) 300 (capsule)		Ejection and recovery of capsule from orbit. (Capsule ejected but not recovered).	Not disclosed	Not applicable	Nickel Cadmium batteries	1 directional, 1 whip	136	450	94	Polar orbit	‡Thor-Hustler. Same as for Discoverer II, except for use of more energetic fuel in stage one.

Launching site symbols: *Believed to be Krasny Yar, near Stalingrad; †Cape Canaveral; ‡Vandenberg.

FUTURE PROJECTS

A number of launching vehicles illustrated on the three-page pull-out are still in the planning or pre-test stage and consequently do not appear in the tabulated list. All are American with the exception of the Blue Streak/Black Knight, a British concept.

ATLAS-ABLE.—Three-stage; mission: launcher for experimental Venus probe. Stage 1, modified Atlas; stage 2, modified Vanguard 2nd stage; stage 3, improved Vanguard 3rd stage.

ATLAS-HUSTLER (Discoverer series).—Two-stage; object: to orbit 3,000 lb. at 300 miles. Stage 1: modified Atlas; stage 2, Bell Hustler.

ATLAS-MERCURY.—Single-stage Atlas; object: to launch man-carrying space-capsule at 100-150 miles (capsule intended to return to Earth on command within 24 hr. using braking rockets and parachutes).

BLUE STREAK/BLACK KNIGHT.—Two or three-stage; object: to orbit 1,000 lb. at 300 miles. Stage 1: modified Blue Streak; stage 2: modified Black Knight. (It was announced by M.o.S. on May 12 that design studies for an all-British satellite launching vehicle had begun.)

CENTAUR.—Two-stage; object: to establish 10,000 lb. in close-orbit, or 2,500 lb. at 23,000 miles; alternatively, could soft-land 730 lb on Moon.

JUPITER-MERCURY.—Single-stage Jupiter. Object: sub-orbital ballistic test for Mercury space-capsule.

LITTLE JOE - MERCURY. — Six clustered solid-propellent rockets. Object: short range ballistic test of Mercury space-capsule recovery devices.

NOVA.—Up to five stages; N.A.S.A. advanced project. Overall height, 260 ft.; launch wt., 4,500,000 lb. Object: could orbit 150,000 lb. "space laboratory" at 300 miles. or soft-land more than 19,900 lb. on the Moon. Stage 1, 4 x 1.5 m. lb. s.t. (liquid oxygen/RP-1); stage 2, 1.5 m. lb. s.t. (liquid oxygen/RP-1); stage 3, 80,000 lb. s.t. (liquid oxygen/liquid hydrogen); stage 4, 40,000 lb. s.t. (liquid oxygen/liquid hydrogen); stage 5, 6,000 lb. s.t. (storable liquid propellent).

REDSTONE - MERCURY. — Single-stage Redstone. Object: sub-orbital ballistic test for Mercury space-capsule.

SATURN.—Up to four stages; N.A.S.A. advanced project. Overall height, 200 ft.; launch wt., 1,160,000 lb. Object: could orbit 19,000 lb. at 300 miles or 3,300 lb. at 23,000 miles. Stage 1, 8 x 187,500 lb. s.t. Rocketdyne H-1 engines; stage 2, modified Titan first stage (twin-chamber engine of 300,000 lb. s.t.); stage 3, 2 x 150,000 lb. s.t. (liquid oxygen/liquid hydrogen); stage 4, 6,000 lb. s.t. (storable liquid propellent).

SCOUT.—Four-stage, all-solid. Object: to orbit 150 lb. at 300 miles, or loft 100 lb. vertically to 5,000 miles. Stage 1, Aerojet General Senior; stage 2, improved Thiokol Sergeant; stage 3, scaled-up Vanguard third stage (ABL X-254); stage 4, improved Vanguard third stage (ABL X-248). Under joint U.S./U.K. agreement, Britain will use this vehicle to orbit satellite equipment beginning 1961.

VEGA.—Two or three stages. Object: to orbit 7,400 lb. at 300 miles, or 1,300 lb. at 23,000 miles; alternatively, could soft-land 730 lb. on the Moon. (One planned mission over next three to four years will be extensive survey of Moon's surface. Vega's final stage would be placed in orbit around Moon with a T.V. camera in payload.) Stage 1, modified Atlas; stage 2, improved Vanguard first stage; stage 3, 6,000 lb. s.t. (storable liquid propellent).

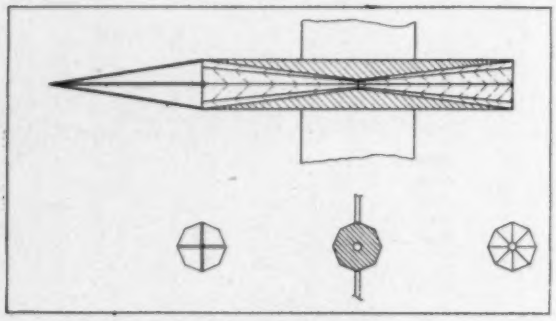
Compression-ignition Ram-Jet

In this summary, specially written for "The Aeroplane and Astronautics," WILLIAM FRANK HILTON, D.Sc., Ph.D., A.R.C.S., D.I.C., F.R.Ae.S., outlines the design for a new supersonic ram-jet proposed in his paper read to the Commonwealth Spaceflight Symposium.*

Dr. Hilton with a model of Seaslug.

RAM-JETS are an efficient means of propulsion at supersonic speeds, but they start to be replaced by rocket engines at Mach numbers of the order of M=3 or M=4. This is because of intake losses, and of thermal stresses in materials. Both these effects arise from the necessity of slowing down the air to subsonic speeds below 400 ft./sec. in order to sustain combustion. At higher speeds the flame is "blown out."

Basis of the new engine is to introduce fuel into the air before compression, then to ignite it when it passes through the shock-wave system in the intake, using the heat of shock-compression to ignite the mixture; in fact, a compression-ignition ram-jet.



Outline of proposed new engine

Thus the familiar bluff-body flameholder, which sustains combustion by recirculating flames in its wake, is now replaced by an inclined shock-wave as a flameholder.

Although some fuels ignite spontaneously at a temperature of 700° C., kerosene then has an ignition delay of 1 second. At 1,000° C. this delay is reduced to a millisecond, which should ensure satisfactory combustion within the engine with the conventional fuel.

Unlike a normal shock, an inclined shock can easily have supersonic speed behind it, so why slow down the air and fuel mixture to subsonic speed at all?

Here lies the secret of success of the proposed engine; sufficient temperature rise to ignite the fuel can be obtained while keeping the flow supersonic throughout the duct. This avoids troublesome effects of boundary layer separation encountered at subsonic speeds in the diffuser of ordinary ram-jets. Naturally, change of geometry would have to be incorporated to permit the flow pattern to be established.

Thus, although a forward speed corresponding to M=5 is sufficient to produce a temperature of 1,000° C., the paper proposes an initial Mach number 7.4, reducing speed to M=2.3 through eight inclined shocks. Stoichiometric combustion would then increase the speed of sound, and lower the Mach number to 1.44, at which point the duct would diverge to accelerate the burnt mixture back towards ambient conditions at the jet discharge.

A duct of octagonal section is proposed with 7° internal wedge angle on each face to produce the required compression. Calculations are still in progress on the nature of the shock interactions down the duct, but considerable extra losses could be tolerated over and above the theoretical, which show the excellent thermal efficiency (work done/heat input) of 65%.

It will be noted that the central spike or Oswatitsch type of air entry has been avoided. It can be shown that this type of intake will result in purely radial flow from M=7, which would be very difficult to fit in to a low external drag engine nacelle.

In the proposed engine, flow deviations on one side are cancelled out by an equal and opposite deflection from the other side of the duct, leaving the flow moving in an axial direction. The central spike type of diffuser has a number of shocks, all of which deviate the air away from the axis.

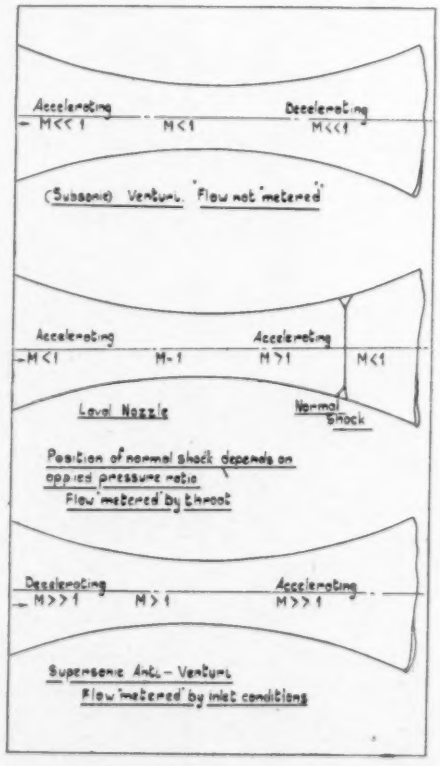
The proposed shape of engine is termed a "supersonic anti-venturi." It has the same shape as a subsonic venturi, narrowest at the centre, but, unlike the subsonic venturi, which accelerates the air at the throat to produce a vacuum, the supersonic flow decelerates at the throat and produces a pressure.

Summing up, this paper presents three fairly new ideas in combination; any of them might be used singly for other types of engine, combined with more conventional solutions of the other problems.

(i) Internal duct compression by criss-crossing shock-waves, springing from "clean" leading edges to avoid boundary layer interactions.

(ii) Use of steady inclined shock-waves from fixed wedge angles as "flame-holders" to effect combustion at supersonic speeds.

(iii) Use of the heat of compression to ignite the mixture spontaneously.



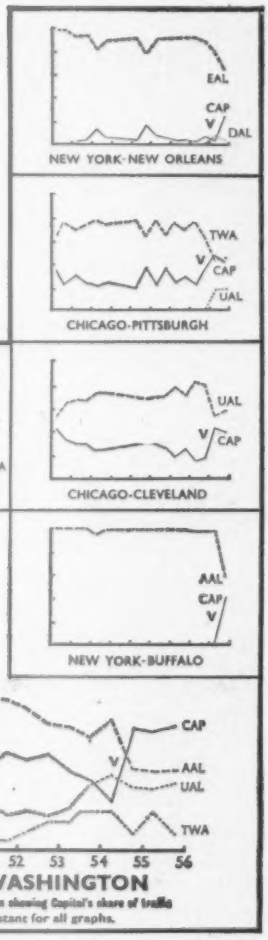
* Now a member of the Advanced Projects Group, Hawker Siddeley Aviation, Ltd., he was formerly Chief Aerodynamicist at Sir W. G. Armstrong Whitworth Aircraft, Ltd.

Operational success clinches the argument for the VISCOUNT

Competitive impact of Viscount 700 a vital factor in Capital's resurgence V=Viscount Upsurge

A recent article in the American "Journal of Air Law and Commerce" (from which the adjoining graphs are reproduced), draws attention to the upsurge of Capital Airline's share of traffic following their introduction of Viscount services. The article continues, "The increase in Capital's share . . . is by no means a simple result of CAB policy. A closer look at Capital's traffic indicates that the competitive impact of the Vickers Viscount was also a vital factor. The remarkable upsurge of Capital in the 1956 section of each of these graphs follows the initiation of Viscount service. The Chicago-Washington route effectively exemplifies Capital's revival in 1955 with the initiation of Viscount services. By March, 1957, this dominance had increased from 42 to 55 per cent, while American's share dropped to 17 per cent". (V indicates period of time the Viscount was first introduced.)

Now, the Viscount 810/40 offers operators even more profitable operation than earlier Viscounts. Payload, speed and range have all been substantially increased, without raising air mile costs, giving considerably greater earning power.



More impressive facts about the VISCOUNT 810

- **Take-off weight now 72,500 lb. (up 3,500 lb.).**
- **Landing weight, zero fuel weight and payload all increased by 2,000 lb.**
- **Maximum-payload range increased from 800 to over 1,200 miles.**
- 365 m.p.h. When re-engined with more powerful Darts, 400 m.p.h.
- Backed by Vickers/Rolls-Royce turbo-prop experience of over 300 Viscounts in service with 40 airlines.
- Viscount 810 is already in service with or on order for T.A.A., Ansett-ANA, Continental Air Lines, Hunting Clan, Lufthansa, Aer Lingus, South African Airways, Pakistan International Airlines, V.A.S.P., Airwork, Cubana, and Sudan Airways.

CUMBERBATCH TROPHY FOR T.A.A.

Trans-Australia Airlines has been awarded the prized Cumberbatch Trophy for safety and reliability in Air Transport after an investigation into operation lasting over four years.

VICKERS VISCOUNT 810/840

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Its mobility and ease of redeployment give the flexibility that is so essential to meet the nation's ever-changing defence requirements . . . **AND THE ECONOMY AS WELL**

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This study of the beginnings of the international association of national rocket and space societies is taken from a paper which ANDREW G. HALEY *read recently in the United States. He is president of the I.A.F. and general counsel of the American Rocket Society.*

International Astronautical Federation

—*Aims and Constitution*

Andrew G. Haley
President I.A.F.

SHORTLY after the end of World War II a co-operative effort to establish a World-wide organization to foster the achievement of space flight as a peaceful project was made by individuals in France, Germany and Great Britain. Recognizing that "this huge task cannot be performed by a single country," as one pioneer put it, representatives of the astronautical societies of those nations, urged to action by a proposal of Germany's Gesellschaft fur Weltraumfahrt and the British Interplanetary Society, worked for more than a year preparing for the founding meeting. Principally through the efforts of A. Ananoff, of France, A. V. Cleaver, of the B.I.S., and H. Gartmann, of the G.f.W., representatives from seven national societies, including those of France, Germany, Austria, Great Britain, Denmark, Spain and Argentina, assembled for the First International Astronautical Congress, which convened on September 30, 1950, in Paris.

During the preceding three decades the great rocket pioneers had undertaken theoretical formulations of rocket and astronautical projects. Hermann Oberth, of Rumania and Germany, Konstantin Ziolkovsky, of Russia, Hermann Noordung, of Austria, Walter Hohmann, of Germany, Robert Esnault-Pelterie, of France, Robert H. Goddard, of the United States, and many other eminent engineers, scientists and industrial experimenters, published basic studies that led to the great mass of literature and to the extensive experimentation which burst forth in 1930.

In the course of their studies and experiments the "rocket pioneers" contributed greatly to the dissemination of knowledge and technical data throughout the World. Many of the "rocket pioneers" corresponded and on a few occasions managed to visit one another.

Here was the beginning of international co-operation in astronautics.

Because of language and distance barriers some of the greatest rocket pioneers were unable to communicate their views to scientists in other nations. Ziolkovsky, for instance, remained in Russia, where he wrote the monumental treatises "Space Investigations By Means of Propulsive Space Ships" (1914) and "A Rocket Into Cosmic Space" (1924). Goddard worked tirelessly on actual rocket hardware, while theorizing, and by 1926 had made the World's first successful liquid-propellent rocket, but he was extremely prudent about disseminating the information.

One of the splendid international pronouncements of this era was the statement contained in a letter by Oberth to Goddard in 1922. With respect to space flight he said: ". . . I think that only by common work of the scholars of all nations can be solved this great problem."

In 1927 the first active forum for astronauts in all nations was established in Germany, the Society For Space Travel (V.f.R.). The German society grew rapidly. Within one year after its historic foundation in Breslau by nine persons the V.f.R. had increased in membership to about five hundred persons and included many of the greatest rocket experts then living, notably, Oberth, von Pirquet, Rynin, Esnault-Pelterie, Hohmann, von Hoefft, Valier and Opel. Members came from Germany, Austria, Russia and France. Similar societies sprang up in other countries. In those days, membership in such societies sometimes did not improve one's professional standing, and much effort of the societies was devoted to proving to the public that astronautics was a science which could be pursued with dignity.

While the societies were engaged in this and more theoretical pursuits, the Austrian, Max Valier, startled his fellow members of the V.f.R., including Oberth, by a spectacular use of an improvized rocket automobile powered by powder charges. He also arranged a rocket mail delivery. Opel was killed in a rocket automobile demonstration. Under these circumstances it was difficult to establish the conservatism of the rocket worker. But courageous people carried on. In 1931 G. Edward Pendray of the American Rocket Society and his wife went to Berlin, tried unsuccessfully en route to locate Esnault-Pelterie, and spent some time discussing rocket-engine problems with Oberth, Johannes Winkler and others. Later A.R.S. rocket motors showed the influence of "Raketenflugplatz," the testing ground of the V.f.R. This visit was none too soon. The German Army confiscated both plans and personnel, by degrees, from the Raketenflugplatz and set up another larger installation near Kummersdorf. By 1932 the German society began to fade.

At this point international co-operation gave an unexpected and strong impetus to the art of rocketry in Germany. This co-operation was the insistence by the Western Powers upon the provisions of the Versailles Treaty which, with catastrophic lack of foresight, had not included rockets on the list of weapons forbidden to the vanquished Germany.

Meanwhile, the influence of the A.R.S. was growing. In 1930 the first bulletin of the Society appeared, containing an article on the "Universal Background of Interplanetary Flight." For many years this early A.R.S. publication carried a column on "News From Abroad," suggesting strong interest in international astronautical affairs. France's great pioneer astronaut, Robert Esnault-Pelterie, presented to the Society an autographed copy of his historic "L'Astronautique," and on January 15, 1931, arrived in New York. Two thousand people turned out at an A.R.S. meeting to hear him speak.

The World was then in the throes of the great depression and rocketry was progressing very slowly. Nevertheless, in 1932 the Russian-Polish astronaut, A. Sternfeld, went to France, where he saw A. Ananoff, leader in French astronautical circles. Ananoff, himself an ex-Russian, has since

then attempted to maintain liaison with Russian astronautical scientists and has been responsible, through his books, for providing the West with knowledge of Russian writings.

In 1933 Philip Cleator founded the British Interplanetary Society, which soon became an influential force in World astronautics. A year later he travelled to Germany to find that the V.f.R. "was no more." The Army had taken over German rocketry.

Within the framework of the establishment of friendly Governments there has been very free exchange of information between individuals, and this undoubtedly has added immensely to the prospects of space flight. In addition to the wartime co-operation with the great scientists and engineers of our Allies, we now have the significant benefit of the knowledge and experience of many of the great German experts. These include such men as von Braun, Dornberger, Ehricke, Klein, Koelle, F. Haber, H. Haber, Schaefer, Stuhlinger, Strughold, and even Hermann Oberth himself—to mention only a few.

Many of the major nations of the World now have rocket and astronautical societies which are united in the International Astronautical Federation. Through the I.A.F., the journals and other publications of the societies are interchanged, membership is open to all qualified persons without regard to national barriers, correspondence is freely interchanged, and personal visits are becoming more and more frequent.

Patrons of the arts and sciences also made earnest efforts to stimulate World-wide activity in astronautics through awards and prizes. Their efforts are regarded as another major step toward international co-operation in astronautics.

By 1937 the French, under the initiative of Robert Lancement, felt that the time had arrived when it would be appropriate to stage an astronautical exhibit. The place and the occasion chosen were Paris, during the 1937 International Exhibition. At the Paris Exhibition astronautical material from America was shown, as well as from Austria, France, Germany, Great Britain and Russia. The Cleveland Rocket Society, to cite an example, sent a half-scale model of a research rocket.

After years of private studies, and with the establishment of national rocket societies, it was only natural that the rocket technicians of the World should associate finally in an international organization. Most people realize that interplanetary flight will cost huge sums, and many, including Germany's G. Loeser, held that "this huge task cannot be performed by a single country."

A Lead from Germany

With genuine desire to affiliate the World's rocket scientists in an effective organization, the German G.f.W. circulated a resolution for close international co-operation among the World's astronautical societies, and in June, 1949, the G.f.W. and the B.I.S. formally proposed that an international congress on astronautics be held. A. Ananoff, of France, made elaborate preparations for the congress and he had the close co-operation of H. Gartmann, of Germany, and A. V. Cleaver of the B.I.S.

The First International Astronautical Congress convened in Paris on September 30, 1950, with representatives of France, Germany, Austria, Great Britain, Denmark, Spain and Argentina present. The United States did not participate. A. Ananoff was elected president of the Congress and H. Mineur was named honorary president. Madame Gabrielle Camille Flammarion and Madame de Vendeuvre were named vice-presidents.

Britain's Cleaver held the chair for the important October 2 session, at which time the general nature of the federation was agreed upon. Eight resolutions were adopted, the substance of which was that an international organization should be formed for the study and development of interplanetary flight.

No technical sessions were held, but the delegates were received at the Palais de la Decouverte, where a visit to the Department Astronautique had been arranged. They were also guests at the atomic facility at Chatillon and at the Observatory of Meudon.

The First Congress was a significant step in the history of rocketry. Science had crossed national boundaries. Some of the most interested parties, such as Oberth, were prevented from attending because of visa trouble, but glowing reports of the Congress were brought back to them. The mission of the proposed new organization was clear: convert the rocket from an engine of war to a peaceful vehicle of interplanetary exploration.

The Second International Astronautical Congress was held in London at Caxton Hall from September 3 to September 8, 1951. The original societies were represented, as was the United States (by A.R.S., the Reaction Research Society, the Pacific Rocket Society, and the Detroit Rocket Society).

At this Second Congress there was considerable technical exchange. On September 8, 1951, a popular technical symposium was held wherein delegates discussed the overall aspects of interplanetary flight. The primary interest of this Second Congress was in the proposed artificial satellite vehicle.

The exchange of knowledge at London was the first organized attempt to promote World co-operation among rocket and astronautics workers. As such, it was a significant milestone in the history of science.

The constitution of the I.A.F., which had been finally drafted during the previous year by the Loeser-Haley committee, was adopted at the Third Congress in 1952. The principle of one vote per nation, regardless of the size of the country or the number of its rocket or astronautical societies, which was strongly advocated by the A.R.S. delegation at London, was approved.

It was decided at the Third Congress that the A.R.S. would be the voting member from the United States.

The Fourth International Astronautical Congress convened in Zurich in the Technical University in August, 1953. Societies from 10 nations were represented and three new members admitted: the Philadelphia Astronautical Society, the South African Interplanetary Society, and the Yugoslavian Astronautical Society. Japan and Israel sent observers. France was not represented. New societies in Spain and Egypt were reported in formative stages.

An important matter considered at the Fourth Congress was the establishment of an official publication. Recognizing the need for year-round means of international dissemination of information among its members, the Congress appointed a committee to set up a quarterly publication, *Astronautica Acta*.

It was evident throughout the Fourth Congress that the I.A.F. was becoming a potent factor in international efforts for scientific co-operation. As a result of the efforts of the Federation, for example, the United States Air Force gave permission to the Swiss Professor Eugster to insert 400-gram packages of nuclear track plates in high-altitude constant-level balloons.

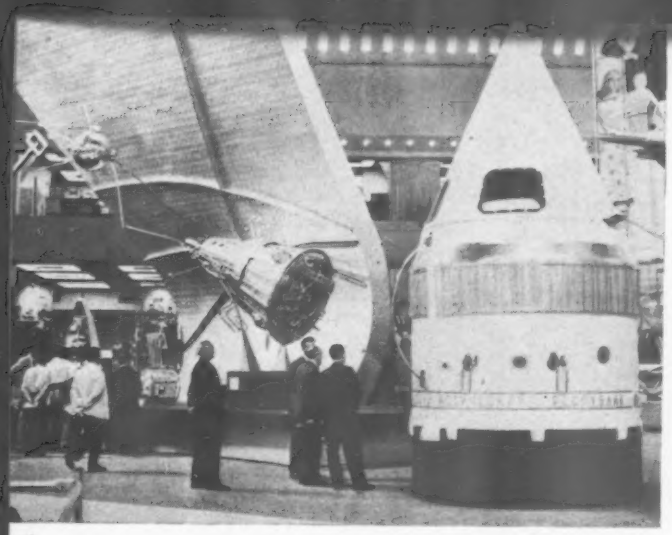
The Fifth International Astronautical Congress met at Innsbruck, Austria, in 1954. The Austrian Society was host. The American Astronautical Society, the Spanish Astronautical Society, the Egyptian Astronautical Society, the Japanese Astronautical Society and the Brazilian Interplanetary Society were admitted to membership. France sent a large delegation, for the first time since 1952, but the French did not seek formal accreditation. Russia again failed to send observers. The Croatian Society for Natural Sciences, Astronautical Section, sent an observer.

With increased membership and other encouraging signs of further international co-operation, the delegates approved publication by Springer-Verlag of *Astronautica Acta*, the editorial function remaining with the I.A.F.

The developments concerning the Earth satellite project, just prior to the convening of the Sixth Congress at Copenhagen in 1955, deserve some background discussion and in consequence a brief digression from the chronological account of the I.A.F. Congresses is made at this point.

The first report of the Space Flight Committee of the A.R.S.,

Space-planners confer at the 2nd I.A.F. Congress which was held in London in 1951 (l. to r.) Mr. E. Burgess (B.I.S. Northern Branch Secretary); Dr. Eugen Sänger (Germany); Kenneth Gatland (B.I.S.); and Irene Bredt.



Russian space-projects at the Soviet Exhibition of Science, Technology and Culture, in New York, including, right, a full-scale model of the Mechta Moon-rocket final stage. At extreme left is Mechta's instrument container to the same scale, and, centre, a full-scale reproduction of Sputnik III.

issued in 1952, called for an orbital unmanned satellite. In 1953 the chairman of the Space Flight Committee invited Alan T. Waterman, director of the National Science Foundation, to attend a plenary meeting of the Committee. Thereafter A.R.S. issued a confidential report stating that the Space Flight Committee proposed that the "National Science Foundation study the utility of an unmanned satellite vehicle to science, commerce and industry, and national defence. Such a study should precede any considerations of feasibility and cost, which could be undertaken if the utility showed a definite need for a satellite vehicle."

On the morning of July 29, 1955, officials of UNESCO signified their agreement to co-operate with the I.A.F. and its space-flight programme. In the afternoon a group of the leading French scientists and engineers agreed to join in the enterprise of peaceful astronautics—to organize a society for this purpose and to join the I.A.F. And in the evening the White House announcement of its satellite project was released from Washington. Interestingly enough, the Space Flight Committee of the A.R.S. had anticipated the details and even much of the language of the American announcement. There were some changes—the "Mouse" became the "Bird," and so on. But the substance of the three reports of the Space Flight Committee in many respects paralleled the official announcement, and it was most gratifying that a great government proposed to go forward with a minimal satellite in connection with the programme of the International Geophysical Year.

The First Russian Attendance

Of particular interest at the Sixth Congress meeting in Copenhagen in August, 1955, was the attendance of a two-man delegation from the Yugoslavia Society: M. Ajvaz and Kosta Sivcev. These engineers attended the meetings faithfully. During the course of the second day of the plenary session K. Ogorodnikov and L. I. Sedov, Russian academicians, also appeared and attended the business and technical sessions of the Congress. The Russians necessarily attended as observers because no rocket society from Russia had applied for membership.

The Seventh Annual Congress of the International Astronautical Federation, held in Rome in 1956, was remarkable in many ways. More than 450 experts in the natural and social sciences attended the meetings and approximately 50 papers were presented. Three new national societies were elected to membership: Committee on Astronautics, Academy of Sciences (Russia); Polskie Towarzystwo Astronautyczne (Poland); and Société Francaise d'Astronautique (France), making a total of 21 voting members.

The Eighth Congress in Barcelona, October, 1957, was highlighted by the news of the launching of Sputnik I. The great achievement of the U.S.S.R. was acclaimed throughout the Congress. Only brief information about Sputnik I was contained in the Barcelona papers, and Spanish censorship prevented distribution of newspapers from other countries.

Most of the conjecture was fairly well cleared up by the end of the Congress, especially when a brief description of the launching vehicle by Y. A. Pobedonostsev, taken from an article in *Sovietskaya Aviatsia*, was circulated.

The Ninth Annual Congress of the International Astronautical Federation, held at Amsterdam, August 25-30, 1958, attracted the largest attendance in I.A.F. history and produced more than 70 technical papers by scientists and engineers from 14 countries, and what may well be the most significant step taken to date toward international astronautical co-operation.

The conference drew a turn-out of more than 400 individuals from some 35 countries.

One of the highlights of the conference was the colloquium on "The Law of Outer Space," held at The Hague. Fifteen countries participated in the colloquium, which approved a resolution, later passed by the Congress, calling for the settling of legal problems in astronautics by a new international convention and creation of a permanent I.A.F. Space Law Committee. The resolution reads as follows:—

(1) That the legal problems created by the development of astronautics be settled through a new international convention; (2) that within the framework of the Federation there be created a permanent legal committee open to lawyers of the various societies or groups affiliated to the Federation, and whose members be entrusted with the study of all the problems of the law of space to be included in the convention mentioned in resolution 1; (3) that the above resolutions be communicated to the Secretary-General of the United Nations, who should be assured of the desire of the Federation to co-operate in any initiative to be taken in the field of astronautics by the United Nations.

The I.A.F.

The Constitution of the International Astronautical Federation eloquently bespeaks the intentions of the member national societies to promote peaceful activities in outer space. Its membership criteria are deliberately broad so as to encompass as many national organizations as possible within the framework of the natural and social sciences, while at all times maintaining highest integrity with respect to qualifications of individual members. Its arrangements for internal working provide for equality of voice among the representatives of all national societies regardless of size.

The I.A.F.'s purposes are to promote and stimulate the achievement of space flight as a peaceful objective; to secure the widespread dissemination of technical information; to stimulate public interest in space flight through the major media of mass communication; to foster research and development; to hold World meetings; and to effect the foundation of a research institute.

The membership of the I.A.F. is open to associations, not individuals. The member societies retain autonomy and the right to withdraw from the I.A.F. Each nation has one voting member, and two other grades of membership exist: non-voting members, who may participate in all activities, receive the I.A.F.'s services, attend meetings, and even vote on specific issues and questions if the Council of the I.A.F. permits such vote; and institution members, which also participate fully in I.A.F. activities and receive its full service, but cannot vote on any issue.

The Council of the I.A.F. is its supreme governing body. The Council elects the I.A.F. officers and members, makes by-laws and general regulations, and approves financial transactions, agenda, and reports. Each voting member society has a representative on the Council.

The I.A.F. has a president, six vice-presidents and a secretary, all elected annually at the plenary meeting (the Annual Congress). The president presides at all meetings and is the chief executive officer of the Federation. The vice-presidents generally report to the president, but if specifically authorized by the I.A.F. Council they may appoint committees to transact I.A.F. affairs. The secretary must reside in Switzerland, the permanent seat of the secretariat. He maintains contact among members, officers and the Council, and he handles the I.A.F. archives, library and financial records.

Voting, as was stated above, is on the basis of a single vote for each nation. Voting may be at a meeting of the I.A.F. or, under certain conditions, by mail. A majority of the entire membership, not just the members present at a meeting, is required for favourable action.

The I.A.F. is supported by contributions made by the member societies and from donations from individuals or other national, international and governmental bodies.

Thirty member societies were recognized as of the time of the IXth Congress of the I.A.F. at Amsterdam in August, 1958. They represent 25 nations. In addition, societies in other nations are in the advanced stages of securing membership.

The aggregate individual membership represented by the constituent societies is 21,240. As of June, 1958, the Israel Astronautical Society had the fewest members, 28, while the American Rocket Society, with 9,300 members, had the most. As the American Rocket Society membership has since grown to more than 12,000, and corresponding increases have occurred in the membership of other societies, the current total exceeds 30,000.

Home-built Gyrocopter

READERS of THE AEROPLANE AND ASTRONAUTICS will have seen pictures and information of a small rotary wing aircraft designed by the Bensen Aircraft Corporation of Raleigh, North Carolina, U.S.A. There are glider and powered versions intended for amateur construction. Copies of the plans are sold by Bensens for this purpose.

Several variants have been designed; one a glider, one powered by a 40 b.h.p. Nelson engine, and the Model B-7Mc, which is the subject of this article and is powered by a 72 b.h.p. McCulloch two-stroke engine, as used in radio-controlled target aircraft. The design has not, so far as is known, received any form of C.A.A. clearance, but is permitted to fly in America under regulations pertaining to experimental aircraft. The materials specified in the plans are largely of commercial grade.

Employing auto-rotating rotor blades the Gyroglider and Gyrocopter are logical developments in ultra-light form of the German Focke-Achgelis kite used by U-boats and the pre-war Cierva Autogiro.

The Bensen B-8Mc Gyrocopter has a 72 h.p. 1,600 c.c. McCulloch drone target plane engine which has been modified for man-carrying flight. This very light engine provides a thrust of nearly 300 lb., which in an aircraft of gross weight of 450 lb. results in a lively performance.

Bensen performance estimates, which must not be interpreted as guaranteed, are as follow:—

Cruising Speed at S.L. ...	60 m.p.h.	Range ...	100 mi.
Max. Speed at S.L.	85 m.p.h.	Endurance ...	1.5 hrs.
Min. Level Speed at S.L. ...	14 m.p.h.	Service Ceiling	16,500 ft.
Take-off Speed at S.L.	18 m.p.h.	Max. Rate of Climb ...	2,000 f.p.m.
Landing Speed at S.L.	7 m.p.h.	Min. Rate of Descent ...	18 f.p.s.
Max. Economy Speed ...	45 m.p.h.		
T.O. Run in Calm Air ...	300 ft.	Ferry Range ...	300 mi.
Landing Roll in 15 m.p.h. wind	0 ft.	Landing Roll in Calm Air	20 ft.

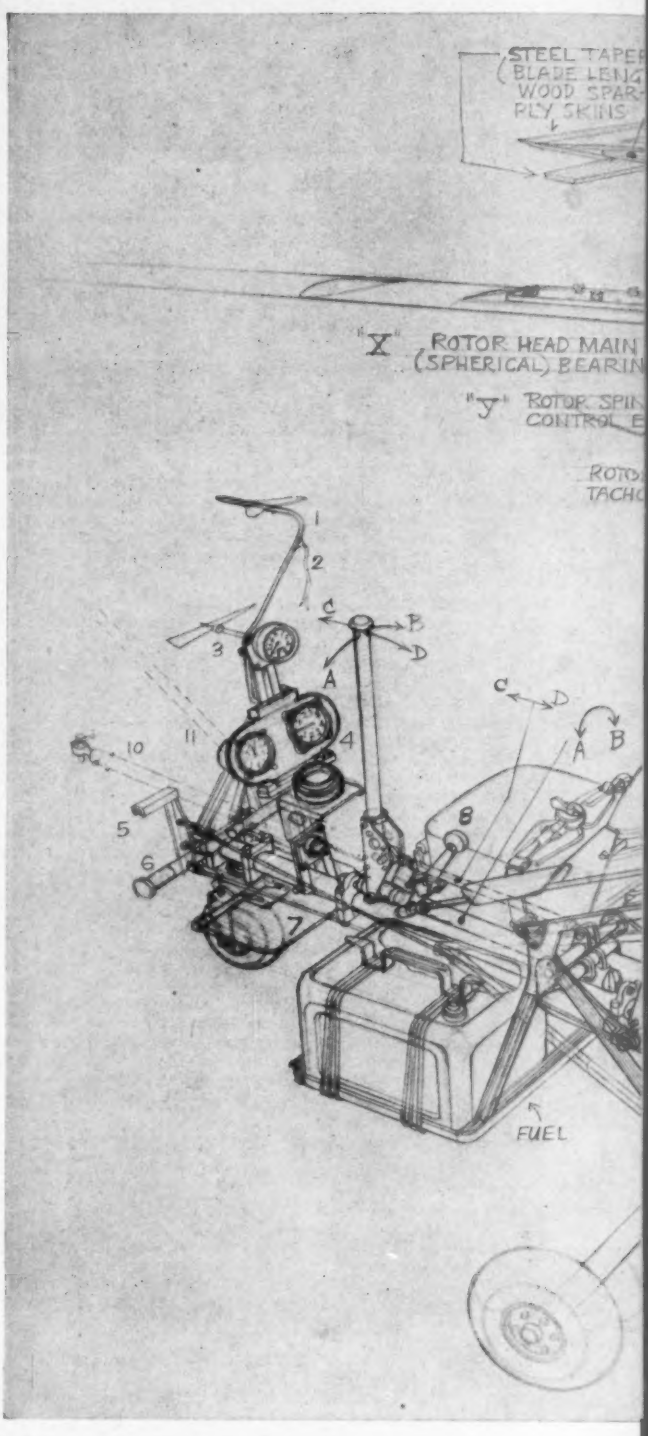
G-APUD, the gyrocopter described in this issue, is the first aircraft of the type to be built and flown in this country. Constructed and test flown by Wg. Cdr. K. H. Wallis of Headquarters Fighter Command, Royal Air Force, it is intended for private use and for further development of the type.

Construction started in August, 1958, and was completed in April, 1959. Although apparently very simple, considerable metal machining is required; much more than in construction of a fixed wing ultra-light aircraft.

Construction of a powered version of a Bensen aircraft should only be undertaken by a person used to aircraft quality machining and welding. He must also be prepared to spend considerable time in the elimination of vibration by tracking and balancing of rotors, and by adjusting resonant frequency of structure and r.p.m. of rotor blades.

G-APUD is currently operating on a limited "Permit to Fly" after inspection by a rotary wing specialist of the Air Registration Board. The relaxed conditions applying to ultra-light fixed wing aircraft allowing inspection by the Popular Flying Association do not apply to ultra-light gyroplanes.

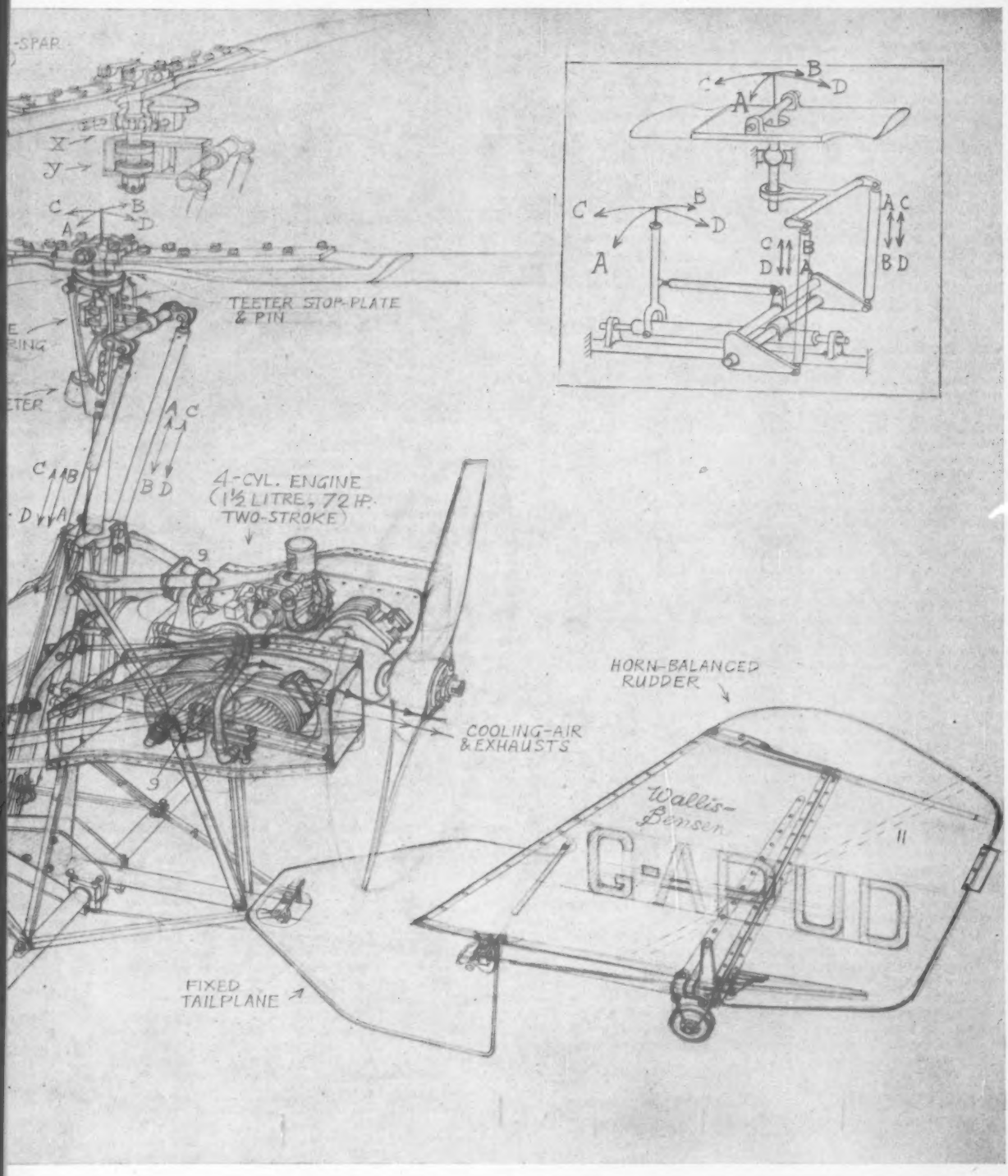
G-APUD varies in a number of ways from the Bensen B-7Mc design. The changes, which were designed by the constructor, are mainly intended to suit the machine to use by a pilot in current fixed-wing flying practice. The most significant change from the original design is the use of an orthodox control system instead of a hanging stick moving in the opposite sense and directly attached to the rotor control



bearing. With this system, all control reactions were reversed.

The additional complication of design and construction was considered preferable to learning unorthodox control movements at the same time as initial tests of a new and unusual aircraft. All control components are carried on ball bearings to minimize wear from feed-back of rotor system vibration.

By providing attachments for easily removable weights fine static balancing of the fabric-covered steel and plywood rotor blades has been made much easier. There are minor refinements in the horizontal stabilizer, and fin and rudder fittings. Increase in radii, and the elimination of stress concentration, has been possible in certain stressed parts. Also, although Bensen designs envisage use of commercial metal and outdoor grade plywood, G-APUD is constructed entirely of approved aircraft materials. Unlike Bensen's design, the pilot's seat on G-APUD allows use of a parachute. It carries the throttle lever and ignition switch on the port side. Quickly detach-



KEY.—1. Static Head and "Horizon Bar," 2. Drift indicator, 3. Prop. Driven A.S.I., 4. Alt., Rate of Climb and Compass, 5. Rudder-Pedals, 6. Nose-wheel Steering, 7. Wheelbrake (Tread Down onto Wheel), 8. Throttle and Parachute Seat, 9. Engine 3-Point Rubber Mountings, 10. Attachable Towing and 11. Blade-anchoring Struts.

Clark drawing copyright "The Aeroplane and Astronautics"

able rotor blade supports and tow-bar fittings facilitate storage and towing on roads. If need be they could be stowed on the aircraft for flight.

The engine has been fitted with a modified centre main bearing housing. This is positively located in the crankcase, after reduction of end float and pre-loading of the crankshaft to simulate propeller thrust. Positive location is intended to prevent fretting between the centre main bearing housing and the crankcase which occurs in the standard engine. Fully caged big end roller bearings are fitted instead of a partially caged type, this being a standard American modification to convert the engine for man-carrying flight.

A Solex 40 mm. carburetter is being used, equipped with a modified float valve and jets. The main jet now has a special fine needle adjustment, a necessary feature if optimum mixture is to be achieved in differing atmospheric conditions.

Fuel is normally delivered to the carburetter by a diaphragm-type petrol pump operated by an eccentric on the crankshaft. To provide a duplicated fuel system the tank is pressurized at 1½ p.s.i. from crankcase compression. A special valve chest has been made, using a non-return valve from crankcase compression, coupled with an adjustable relief valve feeding excess pressure back to the crankcase on the induction stroke. In the event of failure of the pressure system an automatic valve to vent the tank to atmospheric pressure is provided.

The aircraft may be taxied with ease and accuracy using the feet to steer the nose-wheel and to operate its brake. Being

unsprung, apart from the soft tyres and the resilience of the tubular structure, taxiing is somewhat bumpy on a grass airfield.

Flying was preceded by a period devoted to ground checking of the rotor for balance and for tracking. This was done by tying the aircraft down and using the wind to simulate forward speed, about 15 kts. being adequate to turn the rotor at a satisfactory speed. When these adjustments were completed a single rope was attached to a peg about 25 yards upwind of the aircraft and with a wind of about 25 kts. the aircraft was flown as a kite in order to check control response and general handling features. This experience proved to be highly desirable before flying under power.

Restricted Permit to Fly

After examination by the A.R.B., G-APUD was given a restricted Permit to Fly and has now done a total of about eight hours flying, comprising many short flights around the airfield. These have been devoted to giving the pilot experience, adjusting the rotor for correct r.p.m. and tracking (by adjusting the basic incidence of the blades and the trim tabs) and curing various vibrations. G-APUD has been taken to 60 kts. but full performance, either of speed or rate of climb has not yet been examined.

It will be appreciated that the rotor is not driven but autorotates freely. Take-off procedure is primarily a case of getting the rotor up to the correct rotational speed, and the constructor may at a later date fit a mechanical or manual means of accelerating the rotor to about half its final speed. This would reduce the distance required to take off in zero wind conditions.

However, on most occasions there is some wind present and this is used with the aircraft stationary to get the rotor to turn at a reasonable speed in the first instance. Take-off is begun by lining the aircraft into wind and applying the nose-wheel brake. The pilot then reaches up and spins the rotor by hand as fast as possible.

The control column is then held nearly fully back, thus presenting the rotor disc at the angle most favourable for autorotation. The wind causes the rotor to accelerate, and if some engine power is applied the slip-stream assists.

When the rotor has accelerated as much as it is going to in the prevailing conditions (say 100 r.p.m.) the brake is released and the aircraft taxied forward to give an A.S.I. reading of about 15 kts. Too high an air speed when the rotor is turning slowly will not give further acceleration; the A.S.I. speed must be kept at about 15 kts. initially. When the rotor r.p.m. approaches 300 the aircraft rocks on to the tail wheel due to the drag of the rotor. The increase in drag is most noticeable at this stage and more power must be applied or the aircraft will decelerate. At about 20 kts. the aircraft becomes airborne and climbs quite steeply.

Under no-wind conditions on a grass airfield the rotor may take some time to reach flight speed, probably due to disturbance of the blades by bumps. It is then important to restrain one's enthusiasm to become airborne and to keep speeds down, since acceleration of the rotor blades appears to be best at low A.S.I. speeds. There are, however, few days on which there is insufficient breeze to get blades to a good speed prior to start of the run. If a device is fitted to pre-rotate rotors short take-offs should always be possible.

FIRST TEST.—Before flying the Gyrocopter under power Wg. Cdr. Wallis tethered it to a post and flew it as a kite in a 25-knot wind.

MINIMAL FLYING-MACHINE.—Wg. Cdr. Wallis flies his modified Bensen Gyrocopter at Hovercraft height.

Once airborne the aircraft may be flown in the same manner as a fixed-wing machine. Apart from the steep angle of climb and tightness of turns, it feels and responds similarly. Only small throttle openings are needed to maintain height. The fixed-wing pilot quickly becomes used to the additional facility offered by the auto-rotating wing and very slow flight is possible, the aircraft operating virtually as a helicopter in a 15-knot wind. It is quite surprisingly stable under bumpy conditions.

Although very tight turns are possible vigilance is required to guard against loss of height from increased disc loading or when turning down-wind close to the ground. It is also essential to remember that no amount of power will keep the aircraft airborne with the control column held too far back, in an effort to climb to safety. It will not stall, but certainly loses height under such conditions.

Landings are quite straightforward if a little power is used to flatten the approach. Power-off landings appear to be best accomplished from a steep glide approach at about 30 knots followed by a flare-out close to the ground. An early start to the flare-out is to be avoided, since, after an initial check, sinking speed increases and a heavy landing will result. Forward run is negligible even in power-off landings on a calm day. The fast turning backward tilted rotor acts like a reversing propeller.

Forced Landing Capabilities

Properly handled, probably no heavier-than-air aircraft offers better forced-landing capabilities than the Gyrocopter. Lively performance and extremely slow flight are characteristics of this high power-to-weight ratio rotor-plane. For greater economy and cross-country performance an engine of lower specific consumption (McCulloch is .9 lb. b.p.h./hour) is desirable. High-powered motorcycle engines have been used and are better in this respect. However, although engine failure may not be particularly serious in itself, great care should be taken in the choice of an engine. Particular attention must be paid to suitability for fitment of a propeller. A crankshaft breakage might result in rotor blade damage from a lost propeller.

The Gyrocopter's ability to land on a tennis court and, with rotor locked fore and aft, to be taxied or towed away on narrow roads bring it near to the "roadable aircraft." It appears to have its greatest possibilities in the military field for communication or reconnaissance work. Maintenance and inspection are simple and the aircraft requires less storage space than any other. G-APUD is housed with a car in the garage in which it was assembled.

Wg. Cdr. Wallis intends to proceed with further aircraft, the next employing a slightly different rotor blade and hub system. To reduce drag at cruising speeds a streamlined cockpit will be used, although the open-air seat of G-APUD offers an unrivalled view in all directions and adds much to the pleasure of flying the aircraft in the conditions prevailing this summer.

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Recent papers on the subject of supersonic transport, given in the U.S.A., and some comments on the same subject in Britain, have underlined important differences of approach, as well as indicating areas of agreement. The existing situation and some new ideas are summarized here.

Supersonic Possibilities

THREE nations now have a declared interest in the field of supersonic transport—Russia, America and Britain. So far as Russia is concerned, little is known beyond the fact that Mikoyan (co-designer of the MiG series of fighters) is reported to be engaged in the study and design of such an aeroplane. The possibility of a sudden appearance of a Russian supersonic transport some time in the next few years cannot therefore be ruled out.

In Britain, serious study of this subject began in November, 1956, at the hands of a joint industry-Ministry-operator committee, whose report earlier this year recommended that detailed design work should be started on a Mach 1.2 design for 100 passengers, and a Mach 1.8 design for 150 passengers. The Minister of Supply has now invited the aircraft industry to comment upon this report and its recommendations. A certain amount of research work was undertaken for the preparation of this report, under an M.o.S. contract, and several companies, such as Hawker Siddeley Aviation (through its new advanced projects group) and English Electric Aviation are continuing design studies on their own initiative.

In America most of the major manufacturers, and particularly the "big four" transport aircraft designers on the West Coast, have been making studies for several years. In the early part of 1958, the U.S.A.F. directed specific studies to be made into the possibilities of supersonic transport aircraft, and almost all major airframe and accessory manufacturers became involved, directly or indirectly, in this study effort. As

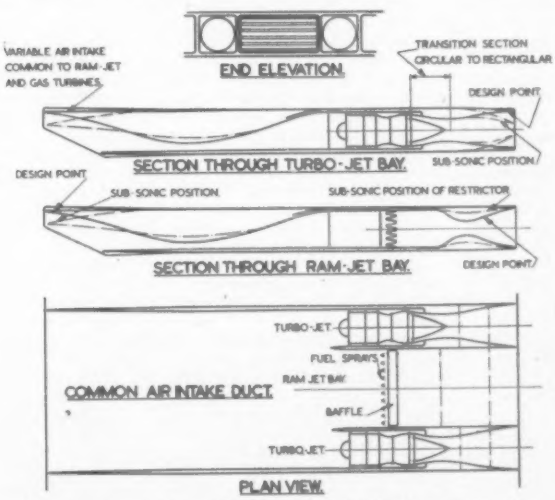


Fig. 1. A typical combination turbojet/ramjet engine bay layout. (Jamison.)

a result, Boeing, Convair, Douglas, Lockheed and North American have all now completed detailed design studies, and engineers of all these five companies, amongst others, have made their views known in publicly-presented papers. Three of these have already been reviewed in THE AEROPLANE AND ASTRONAUTICS. Papers from Lockheed and North American are among those discussed here.

One outstanding result of the American studies is the similarity of the conclusions reached by companies making independent studies. It is generally agreed that the supersonic transport is "feasible, desirable and possibly even inevitable." Moreover, it is agreed that an aircraft designed to cruise at Mach 3-3.5 at about 80,000 ft. is required, carrying about 100 passengers over stages of 3,500-4,000 st. miles. It is interesting

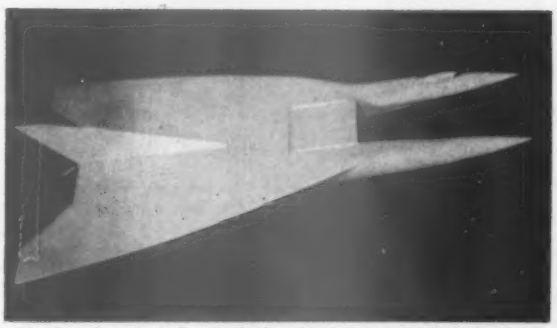


Fig. 2. A typical shape which a combination turbojet/ramjet Mach-3 transport might take. (Jamison.)

to note that the commercial vehicle which is now entering the serious planning and sales stages has a performance so high that it has been experienced, to date, by only one pilot (Capt. M. G. Apt, who flew the Bell X-2 at 2,148 m.p.h. before it crashed in September, 1956).

There can be no doubt that the American industry is now ready to proceed with construction of a Mach 3 transport which could be ready for airline service, if necessary, by 1968 at the latest. Which manufacturer will be first in the field, or whether there will be any measure of collaboration in a programme which may require an investment of $500 million up to civil certification, is not certain.

Boeing, Convair and Douglas are all well placed by virtue of their Mach 0.8-0.9 transports now in production, and Convair can claim the added experience from the World's only supersonic bomber. Lockheed have a wealth of Mach 2 experience through the F-104 and abundant commercial know-how; this company, also, is probably equipped to conduct the most powerful and ruthless sales campaign of any in the business. North American, a commercial outsider, nevertheless has a strong stake through its B-70 Valkyrie and F-108 Rapier prime contracts. It is to complement these two Mach 3 aeroplanes, in fact, that the U.S.A.F. is likely to want a Mach 3 transport. The military contract, whether it is placed before or after development begins, is the real plum in the American supersonic pie.

The airlines, meanwhile, have not been wholeheartedly enthusiastic in their reception of these supersonic proposals—as we showed in our issue for March 13, 1959. More recently,

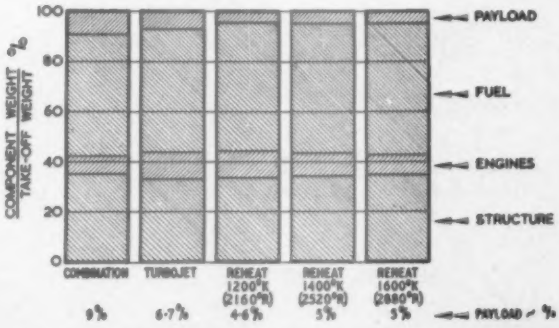


Fig. 3. The effect on payload of alternative methods of propulsion, assuming comparable take-off techniques. (Jamison.)

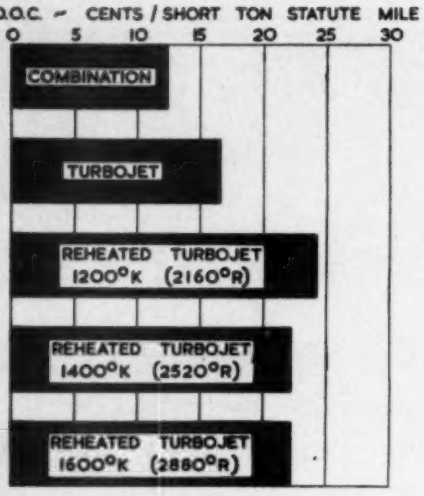

D.O.C. – CENTS / SHORT TON STATUTE MILE
0 5 10 15 20 25 30
COMBINATION
TURBOJET
REHEATED TURBOJET 1200°K (2160°R)
REHEATED TURBOJET 1400°K (2520°R)
REHEATED TURBOJET 1600°K (2880°R)

Fig. 4 A comparison of direct operating costs for the methods of propulsion shown in Fig. 2. (Jamison.)

in the report of the Select Committee on Nationalized Industries (Reports and Accounts), the chairmen of both B.E.A. and B.O.A.C. made it clear that they are far from convinced that the time is yet ripe for the airlines to take any serious steps towards ordering supersonic aircraft. Longer periods of depreciation on new aircraft are, in Lord Douglas' view, essential for the health of the industry; moreover, "all the supersonic airliners that have been studied so far seem to come out as very expensive things to run."

On the other hand, Mr. Hall Hibbard and Mr. Robert A. Bailey, of Lockheed, flatly disagree with the view "that airlines will be unable to finance new aircraft advances in the next decade." "Based on the evidence at hand," they add, "we must disagree with these and other such discouraging statements. Quite to the contrary, design studies and testing, to date, indicate adequate solutions to all major technical problems, making possible an operational supersonic transport as early as 1965. Further, economic studies show attractively competitive seat-mile costs, excellent returns on investments and the potential for ample financing of airline purchases."

Choice of Powerplant

One of the areas of uncertainty in the proposed supersonic transports concerns the powerplant, and various suggestions have recently been made. In a paper given before the I.A.S., Dr. R. R. Jamison, assistant chief engineer of Bristol Siddeley Engines, Ltd., examined in detail the power requirements of the long-range supersonic airliner. Dr. Jamison first argued the case for a Mach 3-3.5 speed bracket on the basis that this was the lowest speed at which the rise in propulsion efficiency of the powerplant can offset the fall in lift/drag ratio which occurs above Mach 0.8.

A comparison of turbojet and ramjet performance showed that the latter meets all cruising power requirements above Mach 2.5 for a weight only 30% that of the equivalent turbojet. This suggested either a composite aircraft (which might have important military applications) or a combination turbojet-ramjet engine in the more conventional aircraft required for commercial use. The latter proposal was then considered in more detail.

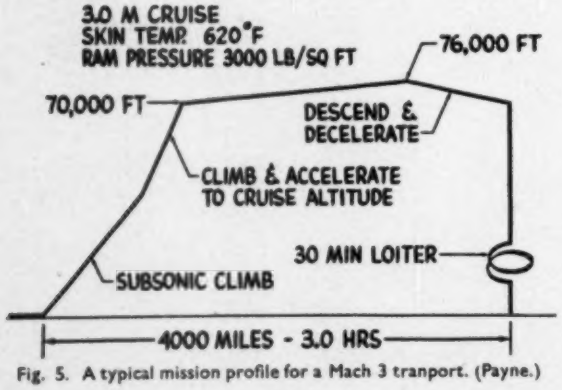


Fig. 5. A typical mission profile for a Mach 3 tranport. (Payne.)

A notable characteristic of the project was the relatively large airflow through the powerplant, with intake and exhaust ducts three or four times as great in area as those in subsonic jet aircraft. It was therefore important to integrate the powerplants and their air ducting with the airframe design; this could be so arranged as to incur virtually no powerplant drag at all under cruise conditions. A typical arrangement is illustrated (Fig. 1).

Dr. Jamison went on to outline a design study for an aeroplane able to fly a 3,100-naut. mile stage against a 40-kt. head wind. The variables in the study were wing loading, aspect ratio, structure weight, lift-drag ratio, installed thrust at take-off and for cruise, engine type (turbojet, reheated turbojet, or combination), tailpipe temperature, installed weight and cruise altitude. In this way a family of aircraft was built up and analysed and it was shown that the combination powerplant allowed the biggest payload to be carried (Fig. 3), and had the lowest direct operating costs (Fig. 4). A typical shape which such a project might take is illustrated (Fig. 2).

The author concluded that a combination-powerplant, Mach 3, 300,000-lb. steel-structure transport, able to carry a 27,000-lb. payload over 3,100 naut. miles with a D.O.C. of 12.4 cents per short-ton statute mile, could be designed and

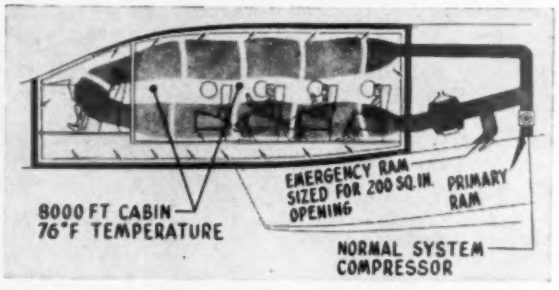


Fig. 6. One way in which cabin temperature and pressure might be maintained at 70,000 ft. (Payne.)

built within the scope of existing engineering techniques. The basic design would have a development potential, by normal engineering methods, up to speeds in the range of 2,500-3,000 knots (Mach 4-5) with substantial gains in range or payload.

Another approach to the problem was suggested by three engineers from the General Applied Science Laboratories in a paper to the A.S.M.E. in June. These authors made a case for staged, or composite, aircraft as a means of producing an economic supersonic transport of smaller size than those suggested elsewhere. The argument is that the enormously high productivity of projected 150-seat 300,000-600,000-lb. Mach 3 transports would mean that very few aircraft were needed and the number of flights per day on a given route might therefore be very small and commercially unacceptable.

A staged transport could be designed to carry 60 passengers at Mach 4 over a 3,500-naut. mile stage for a combined weight of 136,900 lb., compared with 192,000 for a parellel single-stage project. A saving of 42,450 lb. of fuel was possible on the operation, so that both initial costs and operating costs were lower. The cruise vehicle considered had ramjet power, with a single turbojet for landing, having a thrust of 25% of the landing weight. The acceleration vehicle was turbojet powered.

The case for the large afterburning turbojet as the supersonic transport's prime mover was made by Mr. G. C. Rapp, manager of the General Electric J93 aircraft programmes. The J93 is under development for, amongst other types, the Mach-3 North American B-70 Valkyrie, enabling Mr. Rapp to claim that "the development of a satisfactory powerplant . . . for Mach 3 transports has already begun." The supersonic engine would have a thermal efficiency of 35-45% compared with 22-25% for the subsonic turbojet and 35% for the turbofan.

An important characteristic of the turbojet at Mach 3 was that the penalty of using an afterburner was comparatively low. An increase in thrust of over 50%, from the military rating to a low reheat condition, at Mach 3, increased the s.f.c. by only 7-8%. The author suggested that the smallest possible engine could be obtained by sizing it to cruise on low reheat power, and using maximum rating for climb and acceleration; if the 7-8% saving in s.f.c. was significant it could alternatively cruise at the military rating (unaugmented) and use the afterburner for climb and acceleration.

If a non-afterburner engine was sized to give the required thrust for climb and acceleration, the cruising setting would be

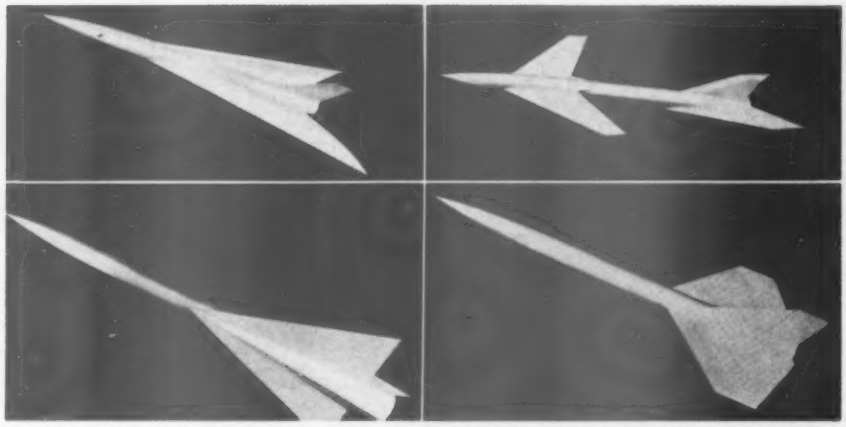


Fig. 7. Four wing-body arrangements examined by Lockheed—twisted and cambered swept wing, tandem wing, cone delta, and trapezoidal wing. (Hibbard and Bailey.)

below the military rating but at Mach 3 the s.f.c. goes up steeply at the lower powers.

Another advantage of the augmented engine cruising on low reheat power was the large power reserve, so that increasing the power of three out of four engines from military, or low reheat, settings to maximum rating would more than compensate for the loss of one engine. As a highly efficient converging-diverging exhaust nozzle was, in any case, mandatory for Mach 3 operations, and not just to suit the reheat condition, the weight penalty of the afterburner was reduced from some 25% to less than 10%.

Other points made by Mr. Rapp were that heating of engine accessories and controls could be reduced if they are encapsulated in a pod, which could be "inerted" with nitrogen to reduce fire risk; that the firewall would have to be a cylindrical shroud covering the entire engine and that the windmilling speed of the engine, in the event of a failure in cruising flight, would have to be controlled by blocking the airflow.

Technical and Economic Factors

In another paper presented to the A.S.M.E. in June, Mr. Fred A. Payne, of North American Aviation, began by justifying the choice of Mach 3 on the basis of drag-rise and s.f.c. He claimed that a 15-25% reduction in present-day direct operating costs might reasonably be expected of Mach 2-3 aircraft designed specifically for transport work. Above Mach 3, costs rose rapidly again. Mach 3 should be chosen rather than Mach 2 to allow for foreign competition, because the cost to an airline of converting is about the same and because the industry's increased knowledge of supersonic flight should operate to reduce costs relatively more at the higher speeds.

Having established that a Mach 3, 3,000-4,000-mile range, 150-passenger aeroplane appears to be desirable, Mr. Payne went on to discuss some of the design requirements. A typical mission profile was illustrated (Fig. 5). The structure of a typical all-steel delta-wing Mach 3 design made use of steel honeycomb or sandwich, and low pressure-ratio turbojet engines using J.P. fuel were indicated. Reheat might be necessary for acceleration but otherwise would probably be avoided. The configuration presents no particular aerodynamic stability and control problems, but the large upper and lower vertical tail surfaces were typical of Mach 3 aeroplanes.

A ram-air system could be provided to compensate for loss of pressure from the normal cabin system, since the ram pressure, when cruising at Mach 3, is about 3,000 p.s.i., corresponding to about 1½ atmospheres (Fig. 6).

From a technical standpoint, said Mr. Payne, it would be possible to have a supersonic transport flying within five to seven years. This was probably too soon for the airlines and greater confidence is needed in the estimation of operating costs. "If the figures should come out as favourably as at present estimated, the age of supersonic transports may be sooner than we think."

The Lockheed Case

In their joint paper before the I.A.S., Messrs. Hall Hibbard and Robert Bailey, respectively vice-president engineering and chief engineer of Lockheed Aircraft, gave some indication of the extent of this company's research to date into the problems of supersonic transport design. The paper is worthy of the closest possible study by British engineers since it is a classic example of the competence and thoroughness with which their American counterparts prepare a case. Whether or not one agrees with the Lockheed view—that a certification date of 1965 for a small Mach 3 transport is realistic to meet the expanding airline market—one is left in little doubt by this paper of the strong position the company already occupies in respect of potential sales to both military and airline customers.

This paper, like several others, started by discussing the choice of cruising speed. The cruise efficiency parameter, $\frac{M \times L/D}{s.f.c.}$ was plotted to justify a choice in the area of Mach 2.4 to Mach 3.5; beyond this latter value, the state-of-the-art in turbojet design was limiting. A detailed design study comparison of two completely comparable transports, Mach 2.4 and Mach 3.0, showed that the latter's development and initial costs were some 23% greater, but direct operating costs in cents per

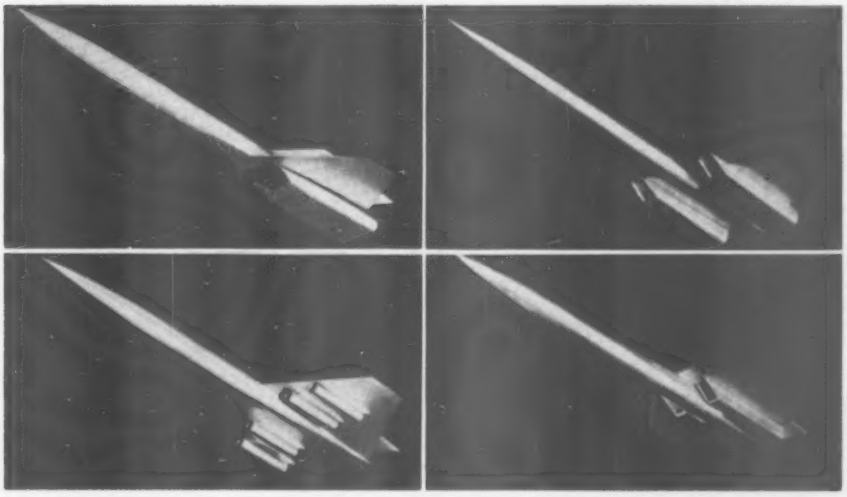


Fig. 8. Suggested powerplant installation—four abreast (penalty in lift/drag ratio 0.42); twin nacelles (penalty 0.57); strut-mounted pods (penalty 0.55); and armpit (penalty 1.34). (Hibbard and Bailey.)

seat mile were 5% lower, because of a 16% higher block speed and improved fuel economy. Moreover, the Mach 2.4 type with its "conventional" structure had no potential speed growth whereas the stainless steel and titanium Mach 3 type had a useful amount of "stretch."

The most important design considerations for a Mach 3-3.5 transport were choice of configuration and propulsion system, structural design and cooling problems. A variety of wing-body configurations were illustrated by the authors (Fig. 7), who showed that the simple trapezoidal or delta wing was very competitive in max. L/D ratio at high speed and retained excellent landing and take-off characteristics.

Approximately 14 unique and independent methods of installing powerplants had been evolved and studied, with many individual variations. Four promising arrangements were illustrated (Fig. 8) and of these the four-abreast arrangement seemed attractive, for its low drag penalty and comparatively few sonic fatigue and flutter problems.

Of the possible nose fuselage designs studied to combine minimum drag with adequate forward view, the only satisfactory design was an aerodynamically optimum one, with no cockpit "step." Optical and mechanical systems to satisfy all flight-vision requirements were therefore being studied and the possibility of a variable geometry forebody (as used in the Fairey FD-2) was raised. Alternatively, a conventional cockpit design might be used, with drag minimized as far as possible.

A specifically supersonic problem was the magnitude of the drag penalty associated with providing longitudinal trim at Mach 3.0 to 3.5. To minimize this penalty, a canard design appeared to have the greatest possibilities.

Structural design approaches which have been considered by Lockheed, using stainless steel or titanium, were illustrated

	Skin—Stringer	Honeycomb (Brazed)	Truss Core Sandwich (Welded)	Sandwich & Stringer (Welded)
Strength	Excellent	Excellent	Good	Excellent
Fatigue	Good	Excellent	Good	Good
Manufacturing Costs	Moderate	Very High	High	High
Inspection & Maintenance	Good	Fair	Fair	Fair
Development Time & Costs	Moderate	Very High	High	High

Fig. 9. Surface panel configurations. (Hibbard and Bailey.)

(Fig. 9); this investigation suggested that the relatively conventional skin-and-stiffener panel was suitable for most primary structure, with honeycomb used where compactness and smoothness were required with minimum gauge.

An air-conditioning system (Fig. 10) could be provided for the same percentage of gross weight as the Electra system. The philosophy was to keep the intake of ram air to a minimum and provide the maximum re-circulation of cabin air. In the scheme illustrated, cooling was accomplished with a thermal barrier of glass-fibre insulation, plus intra-wall circulation of air. Heat absorbed by the wall circulation was removed from the air by a Freon vapour cycle system which carried it to a heat sink. The latter should, if possible, utilize the aircraft fuel, perhaps supplemented by an expendable evaporating water sink.

An extensive study of air intake design for the engine showed that a variable geometry inlet of pivoting ramp type appeared to be the best solution to the problem of off-design inlet drag, which arises from the excess of air delivered at transonic and low supersonic speed by an intake optimized for maximum performance at Mach 3.

Design studies were made by Lockheed to determine the choice of powerplant. They showed that an afterburning turbojet compared with non-afterburning turbojet is more expensive to buy and operate, and led to the conclusion that the non-afterburning engine was best although, ultimately, the size of the vehicle might dictate the choice.

The high thrust/weight ratio of the supersonic transport gave it an excellent take-off performance and F.A.A. landing distances were likely to become the limiting factor in establishing field lengths. Landing distances and speeds would be comparable to those of subsonic jet transports. The noise problem at airports might be relieved by the steep climb-out path and, although attention must be given to flight paths, the authors believed "that the whoosh of the jet and the sonic boom will become as accepted a part of the modern scene as the locomotive whistle and the peal and roll of the thunderstorm."

Another special aspect of supersonic operation concerned fuel reserves. The authors compared the reserves required by a subsonic jet and the supersonic jet on the basis of the proposed SR427 requirements, comprising 10% of flight time, 300-naut. mile diversion and 30-min. hold at 1,500 ft. The

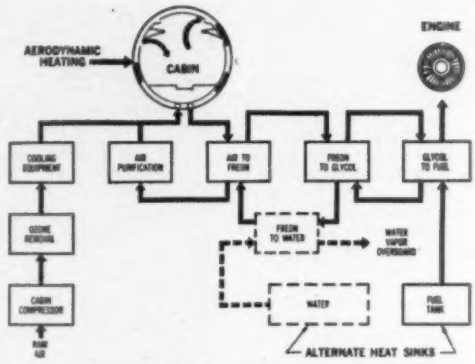


Fig. 10. A suggested air-conditioning system. (Hibbard and Bailey.)

subsonic reserve was 15.1% of total fuel, and that of the supersonic was 16.6%.

In the final, but not the least interesting, portion of the paper, Messrs. Hibbard and Bailey investigated the operating economics of the supersonic projects. Because the A.T.A. formula for estimating D.O.C. took no account of the possible influence on economy of such factors as reduction in frequency due to larger capacity and greater productivity, the company analysed the flight operations of nine airlines—three domestic, three international and three foreign. From one airline in each category a hypothetical but representative airline was then invented, and the application of three different sizes of supersonic transport to its route network in 1965 was studied.

	60-80	110-130	160-180
Number of passengers ..	8.1	7.8	7.0
Daily utilization—hrs. ..	63.7	56.9	54.0
Load factor—%	1.00	.80	.64
Relative total revenues	1.00	.83	.76
Relative total costs ..	1.00	.65	.06
Relative return on investment			

Fig. 11. Operational and economic factors for three sizes of supersonic transport. (Hibbard and Bailey.)

As the table (Fig. 11) shows, the smallest aeroplane appeared to be the most attractive when a complete airline economic analysis was made, despite the fact that a simple comparison of direct operating costs might indicate the opposite.

There was no reason why the airframe manufacturer should not deliver a certificated supersonic transport by 1965. The level of military support depended on whether a prime military mission was established for some derivative of the design, but, in any case, the project was suited to meet a variety of military requirements.

The airlines' future requirements were more easily forecast. Lockheed estimate that 63% of all air traffic will be handled by turbojets by 1975 and that 47% of this traffic could be handled by supersonic transports if the programme were properly timed. An estimate of the capital requirements to pay for these aircraft showed that the measure of outside financing needed by the airlines from 1965 to 1975 would be less than that required to finance the current jet fleets (Fig. 12).

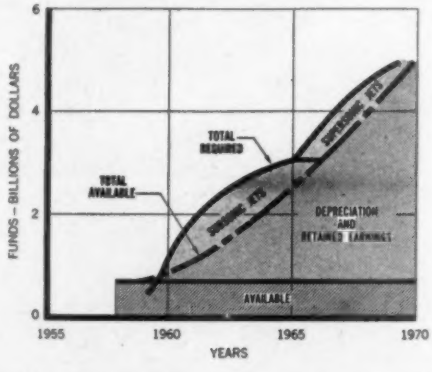


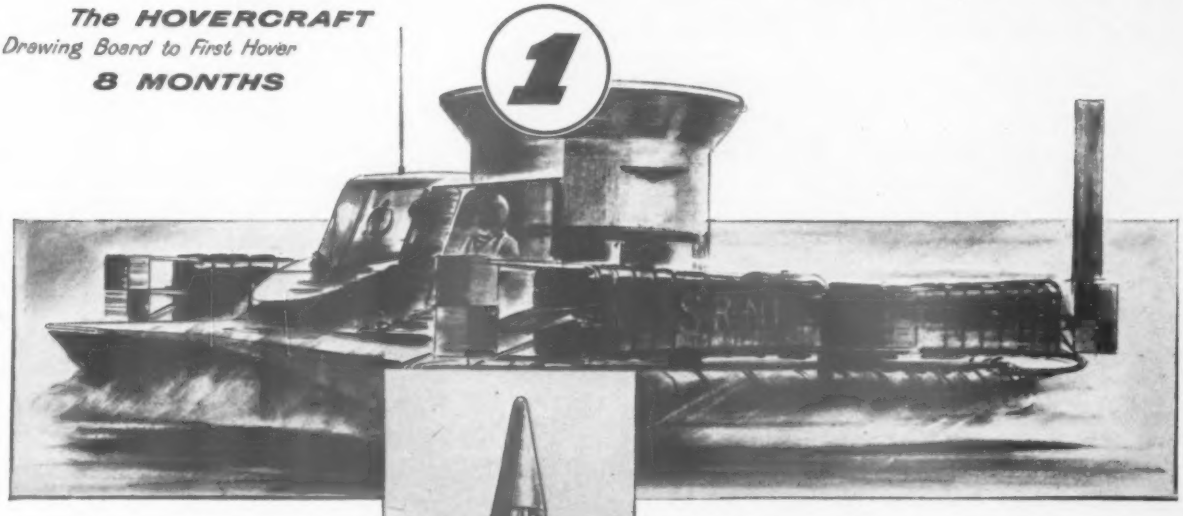
Fig. 12. Financial feasibility of the supersonic transport. (Hibbard and Bailey.)

Hustle

that has made History

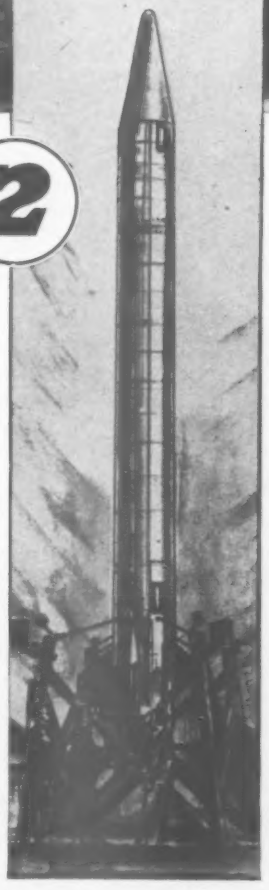
The HOVERCRAFT
Drawing Board to First Hover
8 MONTHS

1



2

The BLACK KNIGHT
Drawing Board to First Firing
2 YEARS



3

The P.531
5-seater HELICOPTER
Drawing Board to First Flight
7 MONTHS

Three times in as many years Saunders-Roe have shown that British brains and British research and manufacturing skill take a lot of beating. These three projects, one a pioneering development of great significance for the future, were successfully completed not only in record time, but at notably low cost. All the scientific and engineering resources of Saunders-Roe are available for both public and private project development. Their technicians will be happy to discuss any project *you* may have in mind.

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The Fighting Services

Fleet Air Arm Disbandment

THE Reserve Aircraft Sub-Command of the Royal Naval Home Air Command was disbanded on August 17 as part of the economy plan to concentrate the Fleet Air Arm in the United Kingdom into a smaller number of air stations. This policy was approved by the Admiralty last year.

Set up in October, 1945, the Reserve Aircraft Sub-Command has been responsible for receiving new aircraft from manufacturers and issuing them to squadrons as required, and for repairing and modernizing the majority of types in service. These responsibilities have been taken over by the Flag Officer Air (Home), whose Headquarters is at R.N.A.S. Lee-on-Solent.

Parachute-Survival Schools Linked

A RECENT R.A.F. amalgamation has been that of the F.E.A.F. parachute and survival schools into one unit, known as the Far East Survival and Parachute School. Based at R.A.F. Changi, it is under the command of Sqn. Ldr. R. D. Mullins.

Since February, 1956, its jungle survival course has trained over 1,000 servicemen of the South-East Asia Treaty Organisation, Commonwealth Services and R.A.F. personnel. The Parachute School was responsible for training all Special Air Service paratroopers in Malaya until the unit returned to the United Kingdom earlier this year. Between its establishment in March, 1952, and its recent amalgamation, the school was responsible for 23,000 parachute descents, of which 2,000 were by its instructing staff.

New Technical Trade

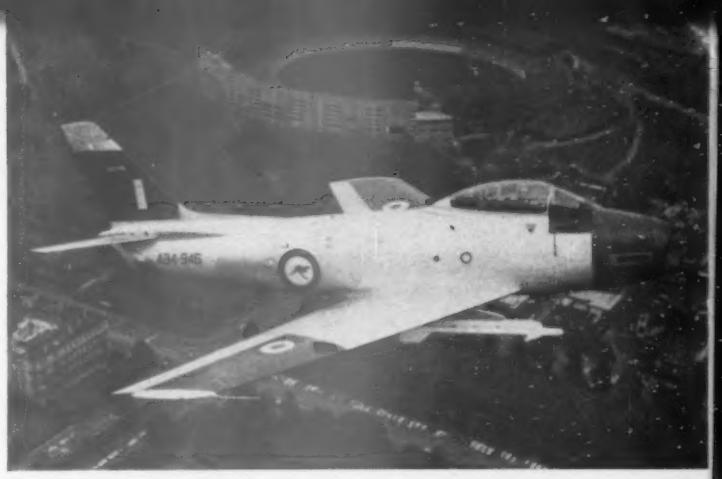
A NEW advanced trade of synthetic trainer fitter, open to both airmen and airwomen, has been introduced into the electrical and instrument trade group of the R.A.F., to deal with the servicing of the various types of flight simulator and portable training aids currently in use or likely to be introduced into the Service in the future. It will be filled by men and women of the rank range from junior technician to chief technician. A course of about six months will be taken by those accepted.

The R.A.F. "At Home"

THIS year 31 R.A.F. stations in the United Kingdom are to be open to the public on Saturday, September 19, as part of "Battle of Britain" week. These are:—

Buckinghamshire: Halton; **Cambridgeshire:** Bassingbourn; **Cornwall:** St. Mawgan; **Devon:** Chivenor; **Hampshire:** Andover; **Huntingdonshire:** Upwood; **Isle of Man:** Jurby; **Kent:** Biggin Hill; **Lincolnshire:** Waddington; **Norfolk:** Coltishall and Marham; **Northern Ireland:** Aldergrove; **Northumberland:** Acklington; **Nottinghamshire:** Syerston; **Oxfordshire:** Benson; **Rutland:** Cottesmore; **Scotland:** Leuchars and Turnhouse; **Shropshire:** Cosford; **Somerset,** Colerne; **Suffolk:** Felixstowe, Honington and Wattisham; **Sussex:** Tangmere; **Wales:** Valley (Anglesey) and St. Athan (Glam); **Warwickshire:** Gaydon; **Yorkshire:** Leconfield, Lindholme, Norton (Sheffield) and Middleton St. George.

At the 34 stations which were opened last year, 1,149,200 people took the opportunity to visit the R.A.F., enjoy flying displays and inspect static ground exhibitions. They subscribed a record sum of £30,000, which was equally divided between the R.A.F. Benevolent Fund and the R.A.F. Association.



R.A.A.F. SIDEWINDERS.—The first R.A.A.F. Sabre to be equipped with Sidewinder AAMs has flown at R.A.A.F. Laverton. Sidewinders are to be fitted to all Australian Sabres based at Butterworth, Malaya.

R.A.F. Appointments

THE following are among recent Royal Air Force appointments:—

Air Ministry: Gp. Capt. R. Berry, D.S.O., O.B.E., D.F.C., and Wg. Cdr. W. A. Rix to the Department of the Chief of the Air Staff.

Bomber Command: Wg. Cdr. H. G. Currall, D.F.C., A.F.C., to Headquarters as Deputy Senior Personnel Staff Officer.

Fighter Command: Wg. Cdr. A. K. Furse, O.B.E., D.F.C., to R.A.F. Neatishead to command, with acting rank of Gp. Capt.

Flying Training Command: Gp. Capt. R. D. Stubbs, D.F.C., to R.A.F. Topcliffe to command; Wg. Cdr. B. L. Duckenfield, A.F.C., to R.A.F. Hornchurch as President of the Aircrew Selection Board; Wg. Cdr. H. L. Lewis, to R.A.F. Manby to the special navigation directing staff; Wg. Cdr. C. L. Godwin, A.F.C., to the R.A.F. Staff College, Bracknell, for directing staff duties.

Technical Training Command: Gp. Capt. C. T. Jackaman, O.B.E., to No. 1 Radio School, Locking, as Senior Technical Officer; Gp. Capt. S. N. Kettle, O.B.E., to the R.A.F. Police Depot, Netheravon, to command.

Maintenance Command: Gp. Capt. J. S. McLean, O.B.E., D.F.C., to No. 16 Maintenance Unit, Stafford, to command; Wg. Cdr. G. Medd to Headquarters for engineering duties; Wg. Cdr. D. Tollerton to Headquarters No. 40 Group for operations duties.

R.A.F. Germany (2nd T.A.F.): Gp. Capt. J. T. Lowe to Headquarters as Senior Legal Officer; Sqn. Ldr. P. T. Bayley to R.A.F. Bruggen to command No. 213 Squadron, with acting rank of Wg. Cdr.

Other Appointments: Gp. Capt. E. A. Johnston, O.B.E., and Wg. Cdr. W. A. Smith, D.F.C., A.F.C., both to the U.S.A.F. Air War College, Maxwell Field, as students; Wg. Cdr. I. D. H. Gibbins to the British Joint Services Mission, Washington; Wg. Cdr. B. J. Scandrett, A.F.C., to SHAPE.

M.E.A.F. VISITORS.—A party of officers from the Pakistan Air Force Staff College, Karachi, seen outside Command Headquarters, Episkopi, during a recent visit to M.E.A.F. Centre; standing is Air Marshal Sir William MacDonald, the C.-in-C., on his left is Air Cdre. Burt-Andrews, Commandant of the P.A.F. Staff College, and on his right, Air Vice-Marshal C. T. Weir, S.A.S.O., M.E.A.F.

Personal Flying

A new organization which has been formed to provide companies with helicopters and fixed-wing aircraft for their directors and executives is Executair, Ltd. This recently started operations by providing a Westland Widgeon helicopter for the use of Laings, the civil engineers.

The Widgeon is based at Elstree aerodrome and is used for making daily trips from the Laing sports ground at Boreham Wood to take key personnel to constructional sites throughout the country. These include the southern section of the London-Yorkshire motorway, and the flights mark the first continuous use of a helicopter by a firm of constructional engineers.

An even more unusual charter will become possible when Executair's Catalina amphibian completes its servicing. This is the sole aircraft of its type in this country, and is fitted out for long-haul executive operations with living accommodation on board for 10 people. To complete the range of executive aircraft, Executair can supply companies with the latest American light twins.

Executair, Ltd., is an associate company of Film Aviation Services, Ltd., of Horley, Surrey. Capt. John Crewdson is a director of both concerns.

• • •

It is apparent from recent public (and private) utterances that the extent of executive aircraft operations in this country is not generally realized. A preliminary estimate suggests that there are some 60 companies in the U.K. with one or more aircraft employed wholly or partly on business flying.

Even so, this number is a very small percentage of the total of industrial companies in Britain, and it is obvious that no serious attempt has yet been made to inform senior executives of the advantages of business flying. Despite the ambitious road-building programme, these advantages are becoming increasingly apparent, since surface traffic is keeping pace with, if not exceeding, the construction of new roads. And yet in the jealously guarded airways, it is rare to see another aircraft.

There is a lot of business waiting for the first organization to establish a large-scale advisory service for business flying. After that, it is up to executive operators to get together in some sort of association to spread the word still further, and lay claim to some of the privileges hitherto regarded as the exclusive prerogative of the Corporations and independent airlines. They will be assured, from what we hear, of every assistance from M.T.C.A.

• • •

Following the tabulation last week on these pages of American light aeroplanes for the private owner of executive operator, we are continuing this service with a range of Continental types likely to be of interest in this country. It will be noted that there are fewer accredited agents for these machines, but they can all be obtained for sterling from the normal aircraft sales companies in London, whose advertisements will be found in our pages.

Once again, the prices and cruising speeds are intended only as general guides, and carry no firm guarantee. The intention where costs are concerned is to indicate the approximate price for each aircraft to the U.K. purchaser, after the payment of 17½% duty, delivery and C. of A. charges. Radio is not usually included, as this is subject to individual customer requirements.

EXECUTIVE TRANSPORT.—Laings, the famous civil engineers, are now using a Westland Widgeon, provided by Executair, Ltd., for taking key personnel to constructional sites throughout the country.

An example of this is provided by the first Super Aero to be imported to this country. This Czech light twin was recently granted a full public transport validation of its C. of A., becoming the first and only type in its class to do so. The purchasers, Maitland Air Charters, installed full airline radio for all-weather operations, including two 44-channel STR.9Z VHF sets; Marconi ADF Type 722 radio compass; and a 75 Mc/s. Fan Marker receiver.

To qualify for a public transport C. of A., the Super Aero was also fitted with a new panel of full flight instruments, with twin Rotax electrical inverters for their operation, and suitable failure lights and change-over switch. The modifications were undertaken by Air Couriers, Ltd., at Croydon.

An interesting new addition to the range of Czech aircraft is the Aero 145, which is identical to the Super Aero except for the installation of M-332-SC engines, with fuel injection and superchargers. These deliver a maximum of 140 b.h.p. with superchargers engaged for take-off and climb, which results in a substantial increase in performance, single-engine climb and ceiling. Cruising speed, supercharger out, remains unchanged.

Of the remaining aircraft tabulated here, there are already examples of the Falco, P136, P166, Jodel D117, Meta-Sokol, Safir, and Morane-Saulnier Paris registered in Britain, and more may be expected to join them. The price quoted for the Tipsy Nipper is for the complete aircraft, but the type is also being offered in kit form, without engine, for £484.

• • •

Of half a dozen or more new light and executive aircraft at the Paris Aero Show, only one not-so-new agricultural biplane, the Grumman Ag-Cat, really made the palm of the old-timer's stick-hand itch.

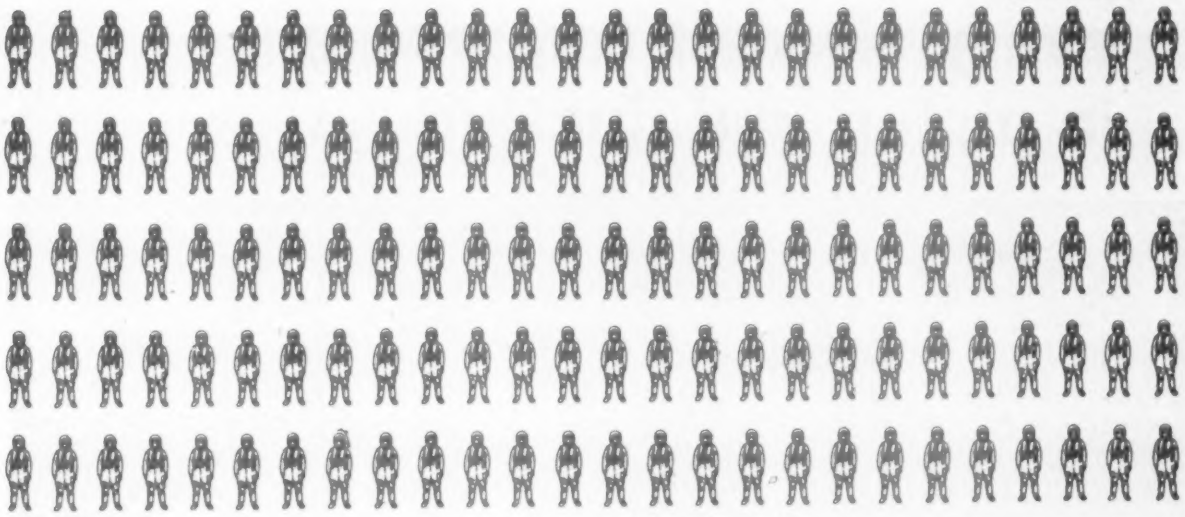
That high-positioned open cockpit, the N-strutted, staggered wings and the radial engine were absurdly nostalgic reminders of earlier days—"absurdly" because the other light aeroplanes to be seen at Le Bourget were so much more practical and useful for the present-day private pilot.

Maybe one can never get away from the effects of early experiences. During the War those who beat about the sky daily on

(*Continued on page 75*)

CONTINENTAL AIRCRAFT FOR PRIVATE AND EXECUTIVE USE

Nationality	Type	Seats	B.h.p. Engine(s)	Cruise speed, m.p.h.	Standard price U.K.	U.K. dealer
Belgian ..	Tipsy Nipper	1	1× 40 Hepu	85	£990	Fairey Aviation, Ltd., Hayes, Middlesex.
Czech	C.Z.L. Super Aero 45	4–5	2×105 Walter Minor 4–III ..	143	£10,750	Gp. Capt. Edward Mole. 3 Red Place, Green Street, Mayfair London, W.1.
	Aero 145	4–5	2×140 M-332-SC	143	£11,750	
	Morava L–200	4–5	2×160 Walter Minor 6–III ..	162	N.A.	
	L–40 Meta-Sokol	4	1×140 M-332-SC	127	£4,400	
	L–60 Brigadyr	4	1×220 Praga Doris M-208B ..	109	£5,350	
	Zlin Z.226T Trener	2	1×160 Walter Minor 6–III ..	121	£4,350	
French ..	S.A.N. Jodel D.117	2	1× 95 Continental C90–14F ..	120	£2,500	Rollason Aircraft and Engines, Ltd., Croydon Airport, Surrey.
	S.A.N. Jodel D.100 Ambassadeur	3	1× 95 Continental C90–14F ..	115	£3,000	
	S.A.N. Jodel D.140 Mousquetaire	4–5	1×180 Lycoming O–360	140	N.A.	
	Morane-Saulnier M.S.760 Paris ..	4	2×880 lb. Turbomeca Marboré II ..	360	£60,000 app.	
German ..	Dornier Do 27	6	1×275 Lycoming GO–480–B1A6 ..	127	£9,695	
	Klemm Kl 107B	3	1×150 Lycoming O–320–A2A ..	118	N.A.	
	Rhein-Flugzeugbau R.W.3–A3 ..	2	1× 65 Porsche 678/0	118	£3,290	
Italian ..	Aviamilano Falco F.8L	2	1×150 Lycoming O–320	186	£4,713	
	Aviamilano Nibbio F.14	4	1×180 Lycoming O–360	186	N.A.	
	Piaggio 136L–1	5+	2×270 Lycoming GO–480–B ..	167	£24,400	McAlpine Aviation, Luton Airport, Beds.
	Piaggio 136L–2	5+	2×340 Lycoming GSO–480 ..	190	£27,700	
	Piaggio P.149D	4–5	1×270 Lycoming GO–480 ..	165	£13,700	
	Piaggio P.166	6–8	2×340 Lycoming GSO–480 ..	207	£33,772	
Swedish ..	SAAB–91C Safir	4	1×190 Lycoming O–435–A ..	150	N.A.	SAAB Aircraft Co., 175 Regent Street, London, W.1
	SAAB–91D Safir	4	1×180 Lycoming O–360–A1A ..	146	£8,695	



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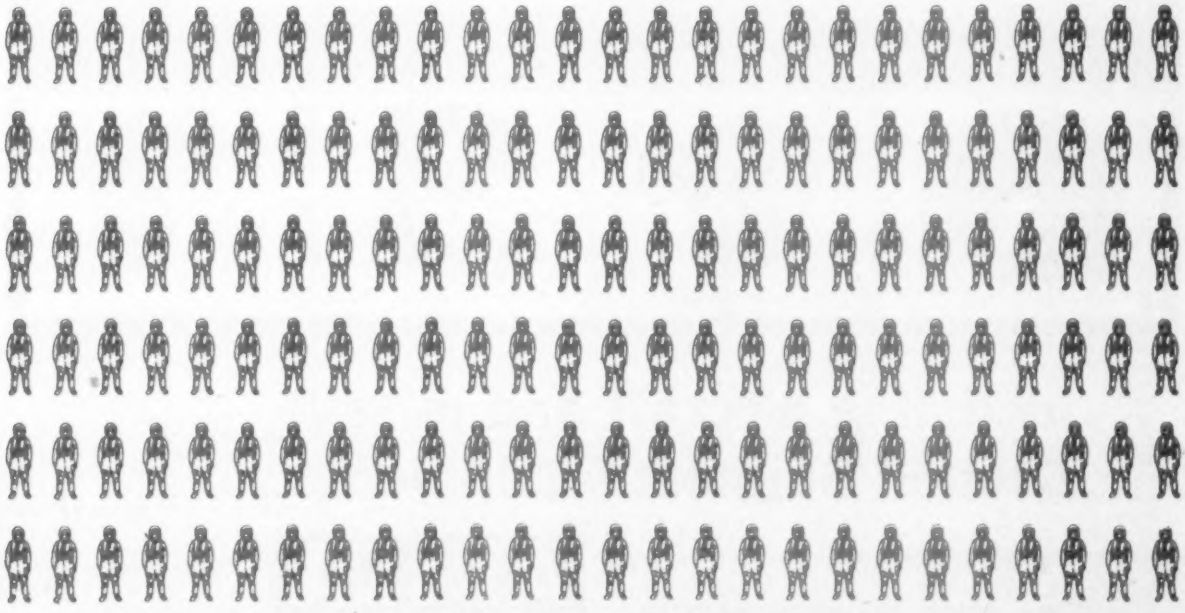

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PIAGGIO DEALERS.—The Luton base of McAlpine Aviation, who were recently announced as the sole U.K. servicing agents and dealers for Italian-built Piaggio aircraft. One of the most experienced of British executive operators, the aviation division of Sir Robert McAlpine and Sons is equipped with a Piaggio P.166 and a Piper Apache.

(*Continued from page 74*)

test or ferry work in a variety of then-modern contrivances were especially glad when a Swordfish, or a Gladiator, or even a Tiger Moth, came up for attention. They felt happier and safer in them. Some specialist aeroplanes like the Ag-Cat have been designed specifically for the kind of flying on which most of the pre-war amateur pilots were brought up.

That kind of flying seems to have gone for ever. The environment is different and the amateur of today must learn to enjoy the mastery of radio-navigation techniques which make each flight into a little airline operation. The private and executive pilots in the U.S.A. have learned to like it that way and unless we find means of following the same kind of pattern there never will be any really serious private flying on this side of the Atlantic. Our pilots have learnt how to fly light aeroplanes. Now they must learn how to operate them.

Gliding Notes

by Dr. A. E. Slater

AN easy, restful atmosphere, entirely free from crisis and panic, awaits anyone who fancies spending a day with the Dublin Gliding Club, 10 miles inland at Baldonnel aerodrome. It will have to be a Saturday or Sunday, because the Irish Air Force uses the place for the rest of the week. They do not seem keen on gliding themselves, but their readiness to help the club with facilities is only curbed by the watchful eyes of civil servants. The latter cannot charge the club less than 50s. a week for use of ground because, they explain, it costs nearly that much to collect it.

Thus, there is any amount of spare room in the hangars but the club gliders have to be kept in trailers. Spare buildings may not be offered for use as a clubhouse, so members must bring their own food and drink for the day. Fortunately, Mrs. Symes, wife of Jim Symes, the chairman, always brings more than she needs for her own party, to allow for the inevitable foolish virgins who bring none, so I did not starve. Anyway, the members will be erecting a hut of their own in the next few weeks.

Dublin Gliding Club has been kept going for seven years by a hard core of enthusiasts who have seen it through good times and bad, and most of them were there during my visit, though the number present would have been swelled by the university contingent if it had been term time.

The club has a Tutor, a Grunau Baby (under repair), and the Kranich, formerly with the Cambridge Club and owned by Ralph Slazenger, who now lives in Ireland, at a place called Durrow Abbey. Luckily, when its trailer was blown over by jet aeroplanes starting up, the Kranich was not inside. There are also a syndicate-owned Petrel and a private Kite 2.

Fred Heinzl, the chief instructor, who met me at Westland Row station, once flew in the Luftwaffe, but his only sport was rowing in Austria until he came to settle in Dublin and heard of the gliding club. He has picked up the Irish vowels but not yet acquired a brogue. He made the best flight of the day, one and a half hours in the Petrel, climbing to 2,400 ft. under cumulus bases at 4,000 ft.; but he had to keep away from the sea as a large blue area devoid of clouds could be seen over Dublin Bay to the east.

The sea breeze, I learned, sometimes reaches Baldonnel in the afternoon and clamps out the thermals, though one member has used the now classic "sea breeze front" characterized by low rags of cloud shooting up the frontal boundary.

The club's most outstanding pilot is John Byrne, the first Irishman to make all the flights for the Silver "C" in his native country. On his distance leg, 60 miles N.N.W. to Ballybay on June 20 in the Petrel, he started with a climb to 12,000 ft. in a wave set up apparently by Kippure, 2,475 ft. high in the Wicklow Hills, 10 miles S.S.E. of Baldonnel. The wave lift was confined to a short beat, not two miles long, and this wave has been caught on only a few occasions so far, though wave clouds are often seen.

Launching proceeded with quiet efficiency while I was there. One of the youngest members to go solo, whom I last saw about 15 years ago, was Mike Slazenger, son of Ralph. At the time he was born, I remember, his father was interested in the theory of "behaviourism," invented by a certain Dr. Watson, who asserted that one of the first reactions of a new-born baby to the outside world is to object vocally on being suddenly dropped and caught again. Ralph duly tried this out on his first-born, who unexpectedly confounded theory by crowing with delight at this first experience of rapid vertical displacement. He was obviously cut out to be a glider pilot, and prophecy has now been confirmed.

The Kranich, in which I was given a check flight by John Clancy before going in the Tutor, handles as ever just like a single-seater, and is still in sound condition after 14 years' use in its adopted countries. With its back hook in use, it rose easily to 1,200 ft., towed by a startlingly decorated ancient vehicle. Recently two soldiers purloined a club towing car to go to a dance and wrecked it, so the object of the decorations is to discourage anyone else from doing likewise unobserved. "Dublin Gliding Club" is splashed over both sides in white paint, and a large skull and crossbones are added; while the other club car, I heard, bears the legend: "Don't laugh—your daughter may be inside."

An Irish Gliding Association was formed in June; the most active clubs outside Dublin are at Carlow, Cork, and the Devil's Bridge in hilly country.

To finish a most delightful day, during the return journey to Holyhead at night, I emerged on deck to be staggered by an amazing sight—one which seems never to have been described before and which, as you might expect, not a single other passenger thought it worth while looking up at: some 30 gulls, with their undersides and wings lit up by the ship's lights, shone bright white against the dark sky as they manœuvred for position in the best lift. Most of them occupied one or other of the two usual upcurrent regions, to windward of the ship's centre and just to leeward of the stern, with the ship doing about 22 knots eastwards in a moderate wind from S.W. Surprisingly, a narrow belt of upcurrent joined the two areas, with occasional lapses, and along this belt one or two gulls were passing continuously in a two-way traffic between soaring centres.

And to complete the picture, down at sea level a shimmering path of light stretched to the horizon under the moon —showing that all those reflecting wave-fronts were steep enough to be soarable.

Powerplants for Missiles

OFFICIAL confirmation has been given that the de Havilland Double Spectre rocket engine powers test vehicles of the Avro Blue Steel ASM engaged on control and aerodynamic flight trials. This is the stand-off bomb which is to increase the striking power of the R.A.F.'s Mk. 2 V-bombers. Static firing trials with the rocket installed in the rear fuselage of Blue Steel have been made at Hatfield, and environmental tests have been made at the Weapons Research Establishment, Salisbury, Australia.

The Double Spectre D.Spe.D.1 comprises a variable-thrust Spectre D.Spe.5 mounted beneath a fixed-thrust Spectre D.Spe.4. Each has a maximum thrust of 8,000 lb. After release of the missile from the bomber, the lower Spectre is fired first; this can be done with the engine throttle at any thrust setting from idling to maximum. The upper boost engine can be fired almost immediately afterwards; both Spectres at this stage are capable of independent operation. As with all current de Havilland rocket engines, the Spectres employ HTP as their oxidant and aviation kerosene as their fuel.

To produce a rocket powerplant for initial flight testing of Blue Steel in the shortest possible time, two existing and proven engines were combined. The Spectre 5 was initially developed for the Saunders-Roe P.177 mixed powerplant interceptor.

The Double Spectre is 58.6 in. long, 36.6 in. wide and 37.5 in. high. Its thrust can be varied between 800 and 16,000 lb.

STRIKE FROM AFAR.—An artist's impression of the Avro Blue Steel stand-off bomb powered by a de Havilland Double Spectre.

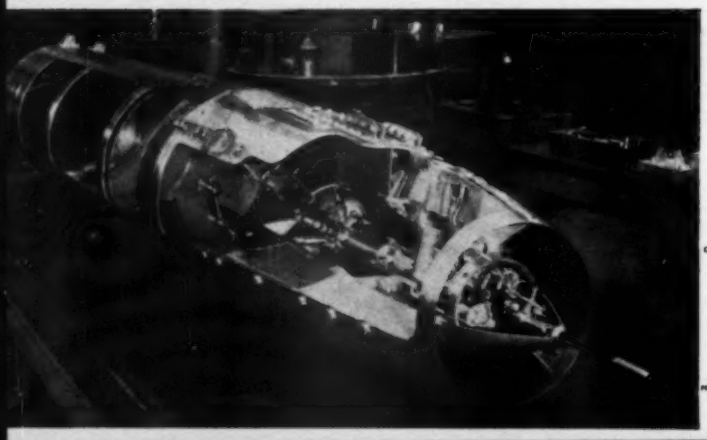
Thor Cutaway

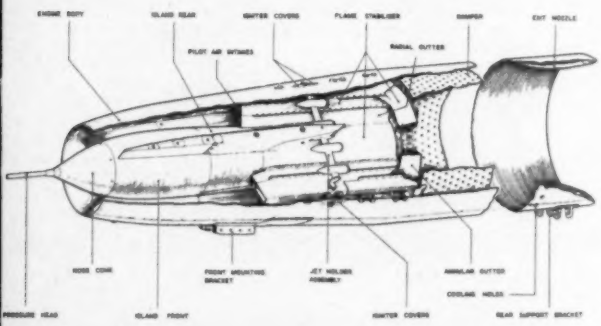
A cutaway BT-1 Thor will be displayed at this year's SBAC Display on the Bristol Siddeley stand; this was the type of powerplant fitted to an early version of the Bristol/Ferranti Bloodhound SAM now in service with the R.A.F.

Less than 9 ft. long and only 16 in. in diameter, the Thor can be carried by two men. Nevertheless, it can develop more than 16,500 lb. thrust at Mach 3 at sea-level. Because it has no moving parts and is largely of sheet-metal construction it is much cheaper to manufacture than a turbojet. Outstanding advantage claimed for it is that at speeds above Mach 2.5 it has better fuel economy than any other engine.

After initial acceleration of the engine by booster rocket, air enters the annular-intake between the nose cone and the engine casing at supersonic speeds, causing a conical shock-wave to spring from the point of the nose cone and intersect the lip of the casing.

In slowing down to subsonic speed the air is compressed and travels down the annular passage round the streamlined island, which is supported from the casing by three vanes and contains the fuel-control apparatus. Fuel is injected through jets and its burning is stabilized by a V-section ring gutter. The combustion area is surrounded by a perforated damper, which reduces oscillations.





THOR INTERIORS.—Developing over 100,000 h.p. at Mach 3 at sea-level, the 16-in. dia. Thor BT-1 is 9 ft. long. Complexity of the fuel control system inside its intake bullet can be seen upper left.

General Aviation News

FAST VANGUARD.—In recent flight trials the Vanguard has achieved a speed of 530 m.p.h. This was reached in a dive at 18,000 ft. in the course of the flight resonance programme, which has now been completed without any problems.

DRONE B-47s.—Lockheed's Georgia Division will convert 12 B-47s to QB-47 drones for use in evaluating North American defence systems. This contract, worth $5 million, follows Lockheed's conversion of two QB-47s for flight evaluation.

CURTISS-WRIGHT AIR-CAR.—Curtiss-Wright announced recently that it was beginning the manufacture of a 300-h.p. 4-passenger vehicle, which would travel at a height of about 10 inches, at speeds up to 60 m.p.h. The first vehicle would be available for delivery in September. It would be 21 ft. long, 8 ft. wide and weigh approximately 2,800 lb. with four passengers and a full fuel load. Suspension of the Air-Car is accomplished through maintaining approximately 0.1 p.s.i. pressure under the vehicle augmented by a deflection membrane. The vehicle can be circular, disc-shaped, oval, square or oblong, as required. Low-pressure, low-velocity air is also used for propulsion.

RED ROTOR.—This model of a new Kamov helicopter, reported to be under construction, was shown in the recent Soviet Exhibition in New York. Believed to have two turbine engines, it was on a model of the atomic-powered ice-breaker "Lenin."

MISSING VICTOR.—A Handley Page Victor B.2 failed to return to Boscombe Down after a test flight on August 20. An intensive search has been made for the aircraft, which is thought to have been lost off the Pembrokeshire coast. It was one of the only two Conway-engined Mk. 2 Victors so far built.

COMANCHE RECORD.—The well-known transatlantic ferry pilot Max Conrad set up a new straight-line distance record on June 2-4 for aircraft of less than 3,000 kg. gross weight when he flew non-stop from Casablanca, Morocco, to Los Angeles, California, a distance of 7,668.48 miles. The flight was made in a 250 b.h.p. Piper Comanche carrying 433 Imp. gal. of fuel in extra fuselage and wing tanks, which gave a useful load some 700 lb. more than the aircraft's normal gross weight. The latter was increased from 2,800 to 5,000 lb., and the take-off run at Casablanca in an 8 knot cross-wind was 4,000 ft. Elapsed time for the flight was 58 hr. 38 min., giving an overall average of 130.9 m.p.h., but the actual distance flown, because of weather diversions, was 8,300 miles. Fuel consumption of the Comanche was about 6.7 Imp. gal./hr..

GLIDING RECORD.—In June, Cdr. Tony Goodhart broke his own 373-mile distance record by flying a Breguet 905 Fauvette 388 miles from Fontainebleau to Pau.

AS is usual in the week preceding the S.B.A.C. Display, the next edition of THE AEROPLANE AND ASTRONAUTICS will be a greatly enlarged number (price 2s. 6d.), containing a review of the British Aircraft Industry and many special features pre-viewing exhibits at Farnborough.

ENGINE EXPORTS.—Figures published by the S.B.A.C. show that during April and May British aero-engine exports were valued at £5,417,506 and £5,570,430 respectively. The £5 million mark has only been exceeded once before—in November, 1958. For the first five months of 1959 the aero-engine export total was £25,018,946.

DISCOVERER VI.—Vandenberg was the scene of yet another launching in the Discoverer series, the sixth, on August 19. In the nose-cone of the satellite was a 300-lb. capsule which again apparently ejected but was not recovered.

"PADDLE-WHEEL" T.V.—N.A.S.A. announced on August 8 that valuable information, including the first crude television pictures taken of the Earth from space, was being received from the "paddle-wheel" satellite Explorer VI. It might be more than a week before an intelligible picture, "a snowy television picture at best," could be composed from the continuous flow of information transmitted by the satellite.

MONKEY TROUBLE.—Baker, the female squirrel monkey which made a successful ballistic re-entry in the nose-cone of a Jupiter I.R.B.M. on May 28, may not be able to breed after all, according to the U.S. Naval School of Aviation Medicine. An attempt to mate Baker with a male squirrel monkey a month ago failed and now scientists have been told by fanciers that squirrel monkeys cannot breed in captivity. Although Baker suffered no obvious ill-effects from her space trip, the ability to rear offspring was considered an important part of the experiment.

AGRICATION GROUP.—An Agricultural Aviation Group has now been formed by the Royal Aeronautical Society in order to "further the use of aircraft in agriculture, forestry, pest control, fertilizing, seeding, chemical application and similar subjects, and to provide facilities for those interested in such matters to meet and exchange ideas and information." This Group is the third to be formed within the Society.

RUSSIAN LONG-RANGE.—According to Moscow Radio recently a "standard" Russian military aircraft has flown 10,658 miles in 21 hr. 15 min. non-stop without refuelling. A similar aircraft was said to have made an earlier flight of 10,532 miles in 21 hr. 2 min.

RED RECORDS.—On August 1, a Tu-104B lifted a 15-tonne (33,069 lb.) payload to 21,325 ft., and flew with it over a 1,000 km. circuit at an average speed of 631.218 m.p.h., setting new F.A.I. records for performance with specified payloads. Another record claimed in the same category is for a two-tonne (4,409 lb.) payload lifted to 66,273 ft. in an unspecified twin-jet aircraft.

AN S.E.5A AIRBORNE.—Apprentices and staff at the R.A.E., Farnborough, have completed the reconstruction of an S.E.5A which was presented to the Shuttleworth Trust by Armstrong Whitworth Aircraft. It has now been restored to flying trim and is believed to be the only example of a Farnborough design now airworthy.

WEATHER SYMPOSIUM.—Birmingham University is holding a "Weather and Flight" Symposium at Preston Montford on September 19-26. There will be lectures in the mornings and evenings and field work in the afternoons. Inclusive fee is £9 5s. Details from the Director of Extra-Mural Studies, The University, Edmund Street, Birmingham, 3.

RICKENBACKER LECTURE.—The 1959 Brancker Memorial Lecture, postponed from April, will be given on September 14 by Capt. E. V. Rickenbacker. His subject is "World Peace through Air Transportation," and the venue is the Jarvis Hall, 66 Portland Place, W.1, at 17.45 hrs.

WORLD'S HEAVIEST.—According to *Boeing Magazine*, the maximum weight of the B-52G is now 480,000 lb., almost certainly the highest weight at which any aeroplane has ever flown.

NEW TRANSPORT.—Three of the first five de Havilland Caribou for the U.S. Army have now flown and the other two are expected to be flying by next month. This is the first air view of the new U.S. Army transport.

Commercial Aviation Affairs

ECONOMY COMETS. — From August 17 to October 20, B.O.A.C. are providing economy seats in one of the two weekly Comet services between London and Montreal. De luxe seating is retained in the forward cabin, with 48 economy seats replacing the first-class accommodation in the rear cabin. About five Comet services to New York will also have economy seats this month and next to meet the heavy demand for that class of service.

JUNE TRAFFIC.—The M.T.C.A. estimate that U.K. airlines traffic on scheduled and inclusive tour services in June (in terms of ton-miles) was 16% higher than in June, 1958. Capacity increased by 9% to give an improvement in load factor of 5% to 64%. In the first half of 1959, the ton-miles increased by 14.3% over Jan.-June, 1958.

AIR-INDIA PLAN.—After introducing Boeing 707s on the London-Bombay service in April, 1960, Air-India International hopes to extend this service to New York by 1961. The 707s will be put onto the Bombay-Tokyo route next summer. The purchase of medium range turbojets or turboprops is being considered by Air-India.

ATLANTIC TREND.—Passenger traffic on the North Atlantic in the second quarter of 1959 increased by 12.5% over the 1958 figure according to IATA. Economy-class passengers increased by 38.7%, and freight increased by 49.8%, with a considerable increase also in all-freight services. The division of traffic in the second quarter was 73.5% economy, 4.5% tourist and 22% first or de luxe.

ALLISON CONVAIRS.—Three conversions of Convair 340/440 transports to have Electra-type Allison 501D-13 power plants are in hand at PacAero Engineering Corp. at Santa Monica. They are for Allison, A.C. Spark Plug and Union Oil Co.

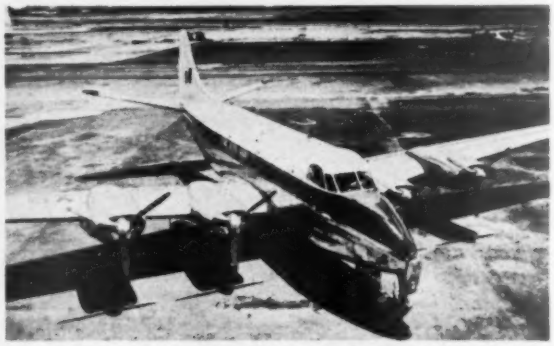
"B" FOR BETTER.—Versions of the Boeing 707 and 720 with turbofan engines will be designated by a "B" suffix. Thus, American Airlines, which last month announced its intention of converting its Boeing fleet to turbofans, will use the 707-120B and 720B versions, both with 17,000 lb. s.t. JT-3D-1 engines. The 707-120B also has a new inboard wing leading edge and additional leading-edge flaps, similar to those of the 720B. Max. cruise Mach number for both B versions is 0.90 compared with 0.88 for the original versions.

FREIGHT TO MOSCOW.—Skyways has applied to the ATAC for permission to operate all-freight services between London and Moscow.

SIKORSKY ORDER.—Chicago Helicopter Airways has ordered three Sikorsky S-61 helicopters for delivery early in 1961. The S-61 is a 25-seat transport with three General Electric T-58-6 gas turbines.

DECCA AIRWAY.—The climb-out sector for Decca-equipped aircraft will be introduced for a trial period on September 1, and provides for a single westbound track, 5 n. miles wide, west of Airway Amber One.

KUWAIT AIRPORT. — Preliminary designs for a new Class A.1 international airport in Kuwait, by Frederick S. Snow and Partners, have been approved and detailed design is now in hand. The airport will be in the desert a few miles south of Kuwait Town and will incorporate all necessary features for the operation of jet transports.



BOOSTED.—Vest Aircraft de Mexico, S.A., has engineered the conversion of the de Havilland Heron to have 250 h.p. Lycoming GSO-480-B146 engines. Compared with the original Gipsy version, the Lycoming-Heron has considerably improved performance.

INDO-CZECH POOL. — Air-India International and Ceskoslovenske Aerolinie have signed a revenue pool agreement for services between Prague and Bombay. The first C.S.A. Tu-104 from Prague was due in Bombay on August 23, and the service makes calls at Cairo and Bahrein.

VISCOUNT OPERATORS.—Following the merging of Cathay Pacific and Hong Kong Airways, the latter's two Viscount 760s have been transferred to another B.O.A.C. associate, Malayan Airways. The three B.W.I.A. Viscount 702s have been transferred to Kuwait Airways now that B.W.I.A. has the later 772s.

M.C.A. VISCOUNT. — Maritime Central Airways has purchased a Viscount 805 from Eagle Airways and put it into service on the routes from Moncton, N.B., to Goose Bay, Gander and St. Johns. It is arranged for mixed freight/passenger loads, with a movable bulkhead.

ROTTERDAM LINK.—K.L.M. is to resume services from Rotterdam, with a daily Viscount service to London starting in November and possibly a service to Hamburg later.

CONVAIR CORONADO.—The name Coronado has been given to the Convair 600 transport. Swissair and S.A.S., with a joint order for five Convair 880s, are likely to change this contract to one for Coronados.

HELP FOR CEYLON.—The FAA has formed a new civil aviation technical group to assist Ceylon in a programme of airways modification. Twenty-five similar groups are already at work in various parts of the World.

TRANSAIR CRASH.—Transair, Ltd., the Gatwick-based independent, suffered its first major accident on August 19 when a Dakota, flying from Barcelona to England, crashed. All 32 occupants were killed.

News About People

R.Ae.S. PRIZE.—On July 29 it was announced by the College of Aeronautics that the Royal Aeronautical Society Prize in Aeronautics for this year had been awarded to James Brian Hargrave, the best student of his year in the diploma course. He was selected for admission to the diploma course on completion of his student apprenticeship at the R.A.E., Farnborough, and is specializing in aircraft electrical engineering.

BOARD APPOINTMENT.—Mr. R. A. Loader, F.I.P.A., has been elected chairman and joint managing director of Samson Clark and Co., Ltd. He first joined these well-known advertising agents in 1916, but between 1924 and 1935 he was with the de Havilland Aircraft Co. During this time he helped to establish the Canadian branch of D.H. and was its managing director for six years. He rejoined Samson Clark as a director in 1935.

U.S.A.F. IN EUROPE.—Gen. F. H. Smith has succeeded Gen. F. F. Everest as commander of the U.S.A.F. in Europe. Gen. Smith previously commanded the U.S.A.F. Air Training Command with Headquarters at Randolph A.F.B., Texas.

HUNTING APPOINTMENT. — Mr. J. R. Sidebotham has joined Hunting-Clan Air Transport as maintenance engineer. He was previously project planning and liaison engineer with Marshalls', at Cambridge.

ARMY AIR CORPS.—Brigadier R. A. Fyffe, D.S.O., O.B.E., M.C., will take over the appointment of Commandant, Army Air Corps Centre, from Brig. G. P. C. Weston, D.S.O., O.B.E., on March 31, 1960.

M.o.S. APPOINTMENT. — Captain E. C. Beard, R.N., has become Director of Royal Naval Aircraft Research and Development at the Ministry of Supply.

T.W.A. APPOINTMENT. — Mr. Howard Goodrich has been appointed T.W.A. district sales manager, U.K., exchanging his present post as Philadelphia sales manager with Mr. Glenn J. Craden, who has been in the U.K. for seven years.

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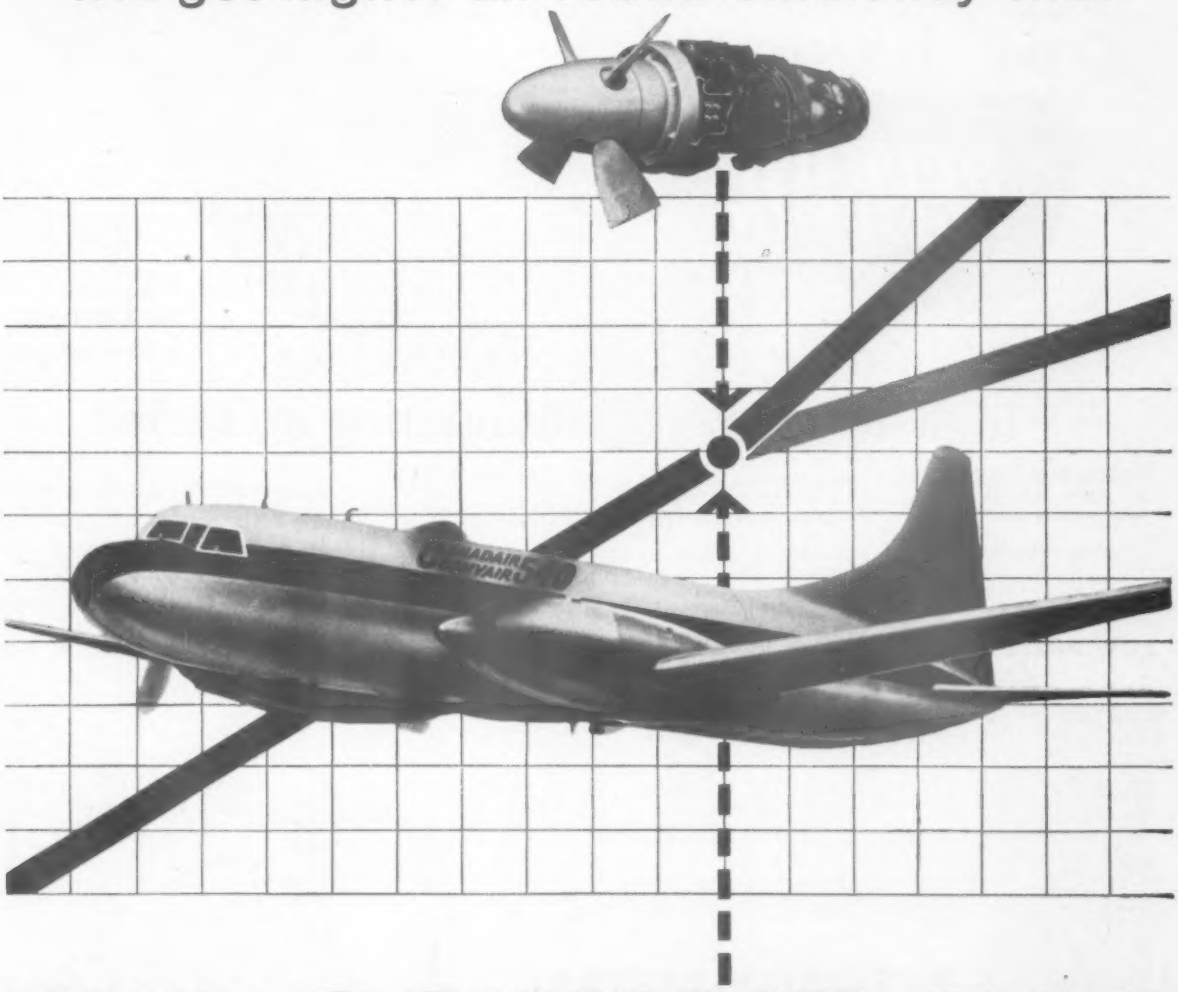

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Correspondence

Put Them Out of Their Misery!

DESPITE letters and criticisms in the aeronautical press concerning the difficulties associated with private flying, it is my belief that the greatest contributory factor has not yet been realized.

It is the exorbitant rent which clubs operating from Air Ministry airfields must pay. The rent for a T.2 hangar for example is as much as £3,400 per year; land rent is as much as 10½d. per square foot.

If private flying is to be encouraged, and there seems to be little enough encouragement for it at present, would it not be possible for service airfields such as Biggin Hill to be placed at the disposal of the various clubs, groups and private owners who fly from there?

Failing this, why not impose an "air space" rental upon all private flying, in order to kill it outright and prevent a lingering death?

London, S.W.1. E. W. CLAPSHAW.

Types-flown Championship

THERE are two civilian test pilots whom I would like to propose as contenders for the "types-flown championship." One is the late Mr. F. P. Raynham, who went to Brooklands about 1909-10 and was regularly testing new aeroplanes from 1911 to 1925. He died in California in 1954, so obtaining his log books might present difficulties.

The other, still happily alive on the west coast of California, is Mr. F. T. Courtney, who learned to fly at Hendon in 1914 and who served with the R.F.C. and R.A.F. from early in that war till 1918. He was test flying for Boulton and Paul's in 1918 and his display of aerobatics in their twin-engined Bourges day-bomber, given at Hendon in May, 1919, is still remembered with respect. An American airman who had just made the first flying-boat crossing of the Atlantic, via the Azores and Lisbon, said of Courtney's exhibition flying, "Gee, that was worth coming 3,000 miles to see."

In 1920 Courtney, deputizing for Raynham, who had broken his wrist, won the Aerial Derby in the Martinsyde Semi-quaver. For some nine years from 1919 he tested prototypes for many British manufacturers, delivered surplus warplanes all over Europe for the Aircraft Disposal Co. and served as reserve pilot for one or two airlines.

He also tested aeroplanes in Holland for both Fokker and Koolhoven. You should, Sir, prevail on your American correspondent, Mr. Stanley H. Evans, who was present on the occasion, to tell your readers precisely what happened—and why—on the first hop of the Koolhoven monoplane fighter.

Since 1928-29 Mr. Courtney has flown regularly in America and was still flying as recently as 1945. Could not he be persuaded to detail for us a list of all types flown since 1914 and also his total flying hours?

May I add that I still look forward to THE AEROPLANE AND ASTRONAUTICS which I have enjoyed since January, 1919?

Romford, Essex. F. A. S. BROWN.

Stock-piling Pilots

I HAVE a suggestion which, to my mind, would make Britain richer in an active "stock-pile" of trained pilots.

Basically the scheme would be to enable a percentage of R.A.F. pilots to leave R.A.F. employment after completing three years' service, including training, providing they become civilian pilots with any one of a number of approved airlines (national or independent), or such firms as employ skilled pilots.

The pilots would have to return to serve for a full month in every 12 on a refresher course in their parent R.A.F. Commands. This reserve training would last for five years counting as the present eight-year minimum term of aircrew engagement. However, pilots would gain no promotion in Service rank, though would receive full consideration within the appropriate company's scale of promotion. (The question of promotion is a moot point which does not greatly affect the main issue.) Owing to his active experience, a pilot should find little difficulty in gaining promotion should he return to full Service employ or upon wartime recall.

Advantages of such a scheme would, including that already mentioned of providing a stock-pile of active, fully trained pilots, provide a healthy complement and source of pilots for the airlines which are, I believe, finding reasonable difficulty in maintaining their aircrew complement. Its results should be to double the aircrew intake into the R.A.F. This is necessary to maintain the standing R.A.F. aircrew strength, thus making use of the large proportion of promising men who are turned down on the selection boards each year owing to limited requirements (this fact was proven by the greater wartime intake).

Such a scheme would surely attract a large number of men who have all the necessary qualifications and health, who would not normally volunteer for aircrew in the R.A.F. although they have sufficient interest, though not the supporting finance, in flying. The crowning advantage as I see it from the country's point of view would be that the Royal Air Force could be brought up to wartime aircrew establishment within a matter of hours if necessary.

The Government would, in its own interests, presumably pay the relatively small sum to convert the pilots to civilian aircrew requirements. On the credit side, such a shadow air force earning their living with a commercial company would be an economic asset.

Seaford, Sussex. C. BARNES.

Groundabout

Interlude for Redundancy. In a two-year-old aviation magazine, I've come across an advertisement which really emphasizes these changing times. The advertiser, an aircraft company, desperately offers "OPPORTUNITIES FOR THESE PEOPLE—*WITH OR WITHOUT AERONAUTICAL EXPERIENCE*"—then strangely lists (among others) Aerodynamicists, Flight Test Engineers and Aero Thermodynamicists. Nowadays, of course, they wouldn't be wanted even *with* aeronautical experience.

*

Some idea of the public-spirited character of Royal Aero Club members can be gathered from this notice displayed on their board:—

"*Car Parking in Piccadilly*

Cars in positions that cause an obstruction to Buses using the stop outside the Club may be removed by the Police, and members are asked to assist in this matter."

*

Marginal. Tim Morice, retired aviation manager of Dunlop's, is i/c flying at Goodwood airfield. "With a five-shilling landing fee we don't make much," he says cheerfully, "especially out of a pilot who has to be warned off with a four and ninepenny red signal cartridge."

*

Press On. Near Dr. Johnson's statue at the end of Fleet Street I met, at opening time, his aeronautical counterpart. Alan Tomkins, of Associated Newspapers, hon. sec. of the Circle of Aviation Writers, is massive, forthright, a doyen among air correspondents. In the classic Wodehouse phrase, Alan, though not actually disgruntled, was far from being gruntled. To my sympathetic question he growled "Spent most of the afternoon trying to get some information out of a Government department—it took them two hours to find out they couldn't find out anything."

*

"Actually, I didn't want to fly to New York but I can't resist their Filet Supréme d'Atlantique . . . ."

by Gren

NOTES AND EVENTS

SYSTEMS LABORATORY.—The control room of the new laboratory built by The British Thomson-Houston Co., Ltd., at Coventry for the development and testing of aircraft AC electrical power components, both as individual units and as complete constant frequency supply systems. It supplements the company's existing laboratories at both Coventry and Rugby.

BUSINESS TAKE - OVER.—A new company has been formed at The Acoustic Centre to take over the business of Detuners, Ltd. The new company—Cullum Detuners, Ltd.—is operating under the same management and staff as previously. Mr. D. J. W. Cullum is managing director and Mr. W. E. Camp, formerly general manager, is also a director. Cullum Detuners, Ltd., is active in all aspects of silencing and noise control in jet engine test beds.

A NAME IN OIL.—In the description of the new Shell non-ash dispersant additive oil known as AeroShell Oil W in our issue of August 14 the name of Shell was omitted. The full title of the company is, of course, The Shell International Petroleum Co., Ltd.

Personal Notices

BIRTHS

Bradshaw.—On August 7, at West Hill Hospital, Dartford, to Janet (*née* Hammersley), wife of Flt. Lt. J. R. Bradshaw, R.A.F.—a son (Michael Joseph).

Calladine.—On August 8, at the West Norwich Hospital, to Cynthia (*née* MacMaster), wife of Flt. Lt. John Calladine, R.A.F.—a son.

Easterbrook.—On July 28, at R.A.F. Hospital, Halton, to Anne, wife of Wg. Cdr. R. L. Easterbrook—a daughter (Philippa).

Fountain.—On August 12, at Limavady, N.I., to Joyce (*née* Lambert), wife of Wg. Cdr. M. G. Fountain, R.A.F.—a son.

Griffiths.—On August 8 at Stamford Hospital, to Jean, wife of Flt. Lt. Brian Griffiths, R.A.F.—a son (Marcus John).

Haven.—On June 7, at King's Lynn, to Emma (*née* Boolan), wife of Flt. Lt. R. C. Haven, R.A.F.—a son (Lawrence Richard).

Hughes.—On August 4, at Northallerton, Yorkshire, to Wendy (*née* Norman), wife of Flt. Lt. E. J. A. Hughes—a son (David Norman).

Hyam.—On July 31, at Nordsee Klinik, Sylt, Germany, to Mary (*née* Fenton), wife of Flg. Off. C. Hyam, R.A.F.—a son (Nicholas Mark).

Moore.—On June 15, to Margaret (*née* Ryan), wife of Sqn. Ldr. David Moore, R.A.F.—a son.

Pinchbeck.—On July 31, at Ronkswood Maternity Hospital, Worcester, to Margaret (*née* Smith), wife of Sqn. Ldr. D. E. Pinchbeck, R.A.F. (Retd.)—a daughter (Sarah Ann).

Trant.—On July 31, at R.A.F. Hospital, Wegberg, B.F.P.O. 40, to Anne, wife of Sqn. Ldr. J. P. Trant—a daughter (Jane Louise).

Woods.—On July 10, at R.A.F. Hospital, Aden, to Betty (*née* Hoyle), wife of Sqn. Ldr. J. C. Woods, R.A.F.—a son (Timothy John).

MARRIAGE

Bullers—Pendleton.—On August 8, at St. James's Church, Kidbrooke, Flt. Lt. Roy Frederick Bullers, youngest son of Mr. and Mrs. Walter Bullers, of Blackheath, to Sheila Joyce, only daughter of Mr. and Mrs. Gerald Pendleton, of Blackheath.

DEATH

Karop.—On July 1, in a flying accident in the Southern Cameroons, Michael Churchill Karop.

Aviation Calendar

August 27-29.—Commonwealth Space-flight Symposium, organized by British Interplanetary Society at Church House, Westminster, **London,** S.W.1.

August 30.—Flying meeting, organized by Auto-Sport, Ltd., Sandown, **Isle of Wight.**

August 31-September 5.—10th Congress of the International Astronautical Federation at Church House, Westminster, **London,** S.W.1.

September 1. — Aviation Forum at Imperial Hotel, Victoria, **London,** S.W.1.

September 4.—I.A.F. Space-law Colloquium at Great Hall, Lincoln's Inn, **London,** W.C.1.

September 5-6.—B.W.P.A. Flying Meeting, **Sywell,** Northants.

September 7-13.—S.B.A.C. Display and Exhibition at **Farnborough.**

September 10.—The Helicopter Association of Gt. Britain Annual Dinner, Dorchester Hotel, Park Lane, **London,** W.1.

September 10.—University of London extra-mural studies lecture, "Atmospheric Energy Radiation," by Dr. R. S. Scorer, M.A., Ph.D., at the Kronfeld Club, Basement, 74 Eccleston Square, **London,** S.W.1.

September 11-13.—Rally at **Baden Baden** organized by the German Aero Club.

September 13. — Newcastle-upon-Tyne Aero Club "At Home" and air race, **Woolsington.**

September 14.—Brancker Memorial Lecture, "World Peace Through Air Transportation," by Capt. E. V. Rickenbacker (Eastern Airlines) at the Royal Inst. of British Architects, 66 Portland Place, **London,** W.1, at 17.45 hrs.

September 14-20.—Battle of Britain Week.

September 15-18.—International Agricultural Aviation Conference at College of Aeronautics, **Cranfield,** Beds.

September 19.—International balloon competition at **Zürich.**

September 19.—R.A.F. "At Home" Day.

September 19.—Aviation Forum's Airborne dinner. Rendezvous at **Blackbushe Airport** 18.15 hrs.; take-off 19.00 hrs. 42s. per head. Book, John Elliott, Hon. Treasurer, Aviation Forum, 14 Tudor Court, Gunnersbury Ave., W.5.

Company Notices

NEW COMPANIES

Aero Stills, Ltd. (633,353).—Private co. Reg. July 23. Cap. £3,000 in £1 shares. Low-altitude aerial photography, etc. Directors: Alwyn C. Nockolds, Greenhouse, Wisborough Green, Sussex; James S. Chaundler, The White House, Wisborough Green, Sussex; and Brian C. Kemp, The Park, Wisborough Green, Billingshurst, Sussex. Reg. office: 5 Kensington Church Street, W.8.

Air Britannica, Ltd. (630,208).—Private co. Reg. June 12. Capital £100 in £1 shares. Carriers and operators of all kinds by air, land, water or in space of persons, etc. Directors: Donald C. T. Bennett and Elsa Bennett, both of Deepwood House, Farnham Royal, Bucks. Reg. office: Deepwood House, Farnham Royal, Bucks.

Airfield Filling Station, Ltd. (631,297).—Private co. Reg. June 26. Cap. £1,000 in £1 shares. Garage proprietors, etc. Directors: Clifford G. Yaxley, Scratby Hall Farm, Scratby, Norfolk, director of Norfolk Greyhound Racing Co., Ltd., and Leslie G. Wright, 21 Collingwood Road, Great Yarmouth, director of Anglian Air Charter, Ltd. Secretary: L. G. Wright. Sols.: Hill and Perks, Norwich. Reg. office: Yarmouth Road, Caister on Sea, Norfolk.

Air Touring Club, Ltd. (632,971).—Private co. Reg. July 17, as a Company Limited by guarantee without share capital. To own, maintain and conduct The Air Touring Club. Management is vested in Committee, first members Geoffrey B. Cartner, 5 Winchester Road, Hanworth, Middx., and Bernard R. Cleary, 63 Kenilworth Avenue, Wimbledon, S.W.19. Secretary: Bernard R. Cleary. Reg. office: 63 Kenilworth Avenue, Wimbledon, S.W.19.

Barnard Drake and Partners, Ltd. (633,271).—Private co. Reg. July 22. Cap. £5,000 in £1 shares. Designers, manufacturers of and dealers in components, parts, engines, and other accessories for prototype and aircraft of all kinds, etc. Permanent directors: John B. Drake, 15 Beech Avenue, Chichester; Peter C. Drake, 16 McKinley Road, Bournemouth, and Mrs. Elizabeth S. Drake, 15 Beech Avenue, Chichester. Secretary: A. F. Janes. Sols.: Wanrop and Falconer, Chichester. Reg. office: 6 The Hornet, Chichester, Sussex.

Baynes and Turner, Ltd. (631,072).—Private co. Reg. June 25. Cap. £1,000 in £1 shares. Aeronautical and general engineers, electrical, atomic, electronic, mechanical and production engineers, etc. Subscribers (each with one share): Percy O. Ansell, commercial manager, and George A. Corderoy, assistant manager, both of 116 Chancery Lane, W.C.2. First directors not named.

New Patents

APPLICATIONS ACCEPTED

818,144.—Boeing Airplane Co.—"Detachable sealed joints for securing pliant sheet material to a support structure."—Nov. 10, 1955.

818,188.—Koninklijke Luchtvaart Maatschappij N.V.—"Aircraft wings."—Sept. 21, 1956. (Sept. 24, 1955, and Sept. 11, 1956.)

818,291.—Westland Aircraft, Ltd.—"Warning devices on rotary wing aircraft."—May 13, 1957. (May 14, 1956.)

818,357.—Aerotecnica S.A.—"Automatic control of aircraft."—June 24, 1955. (June 26, 1954.)

818,358.—Aerotecnica S.A.—"Rotary wing aircraft."—Oct. 31, 1955.

Printed specifications of above available Aug. 12, 1959. Opposition period expires Nov. 12, 1959.

818,383.—Fairey Aviation Co., Ltd.—"Launching of objects from aircraft."—Apr. 26, 1956.

818,448.—English Electric Co., Ltd.—"Rocket motor attachments."—Dec. 9, 1955. (Dec. 14, 1954.)

818,487.—United Aircraft Corporation.—"Helicopter."—May 28, 1957. (June 1, 1956.)

818,613.—Sperry Rand Corporation.—"Altitude-indicating instrument for aircraft."—Feb. 26, 1957. (March 26, 1956.) (Addition to 811,062.)

818,614.—Sperry Rand Corporation.—"Indicating instruments."—Feb. 26, 1957. (Divided out of 818,613.)

818,403.—Aerotecnica S.A.—"Rotor blades for rotary wing aircraft."—Oct. 31, 1955.

818,490.—General Motors Corporation.—"Turbojet engines."—Nov. 8, 1957. (Nov. 9, 1956.)

Printed specifications of above available Aug. 19, 1959. Opposition period expires Nov. 19, 1959.

819,515.—Soc. d'Applications des Machines Motrices, and Rohacs, E.—"Joystick handle."—June 7, 1957.

819,226.—Zborowski, H. P. G. A. R. von.—"Aircraft having tunnel-shaped wings."—March 15, 1957. (March 16, 1956.)

Printed specifications of above available Sept. 2, 1959. Opposition period expires Dec. 2, 1959.

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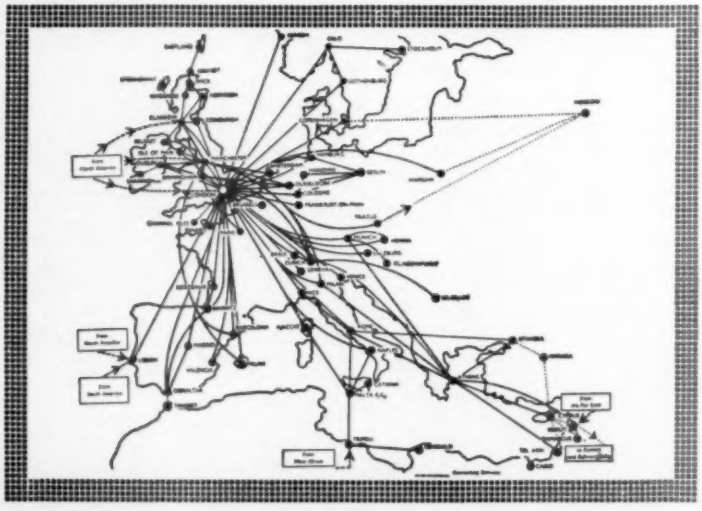

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INDEX TO ADVERTISERS

Name	Page
A	
Aero-Enterprises (Boreham Wood), Ltd.	21
Airline Air Spares, Ltd.	24
Air Parts Ltd.	23
Air Service Training, Ltd.	24
Aviation Traders, Ltd.	22
Avica Equipment, Ltd.	16
B	
Boulton Paul Aircraft, Ltd.	Inside Back Cover
Bristol Siddeley Engines, Ltd.	12
British European Airways	20
British Oxygen Aro Equiment, Ltd.	3
British Refraisil Co., Ltd.	18
Burnley Aircraft Products, Ltd.	7
C	
Central Office of Information—R.A.F. Recruiting, Commissioned Air Crew	19
Ciba (A.R.L.), Ltd.	23
Cross Manufacturing Co. (1938), Ltd.	21, 23
D	
De Havilland Aircraft Co., Ltd.	Front Cover
E	
English Electric Co., Ltd., The (Guided Weapons Division)	10
F	
Ferranti, Ltd.	23
Fischer Bearings Co., Ltd.	Inside Front Cover
G	
General Electric Co., Ltd., The	4
H	
Handley Page, Ltd.	22
Hawker Siddeley Aviation, Ltd.	8
L	
Lucas, Joseph (Gas Turbine Equipment), Ltd.	Back Cover
M	
Marshalls Flying School, Ltd.	22
Martin-Baker, Aircraft Co., Ltd.	15
Ministry of Transport	22
Motoimport	6
N	
Napier, D., & Son, Ltd.	17, 22
P	
Palmer Aero Products, Ltd.	1
R	
Rolls-Royce, Ltd.	11
Rotax, Ltd.	14
Royal Rhodesian Air Force	23
Rozalex, Ltd.	22
S	
Saunders-Roe (Aviation), Ltd.	13
Shackleton, W. S., Ltd.	21
Short Bros., & Harland, Ltd.	5
Smart & Brown (Machine Tools), Ltd.	4
Smiths Aircraft Instruments, Ltd.	2
T	
Teleflex Products, Ltd.	18
V	
Venner Accumulators, Ltd.	6
Vickers-Armstrongs (Aircraft), Ltd.	9

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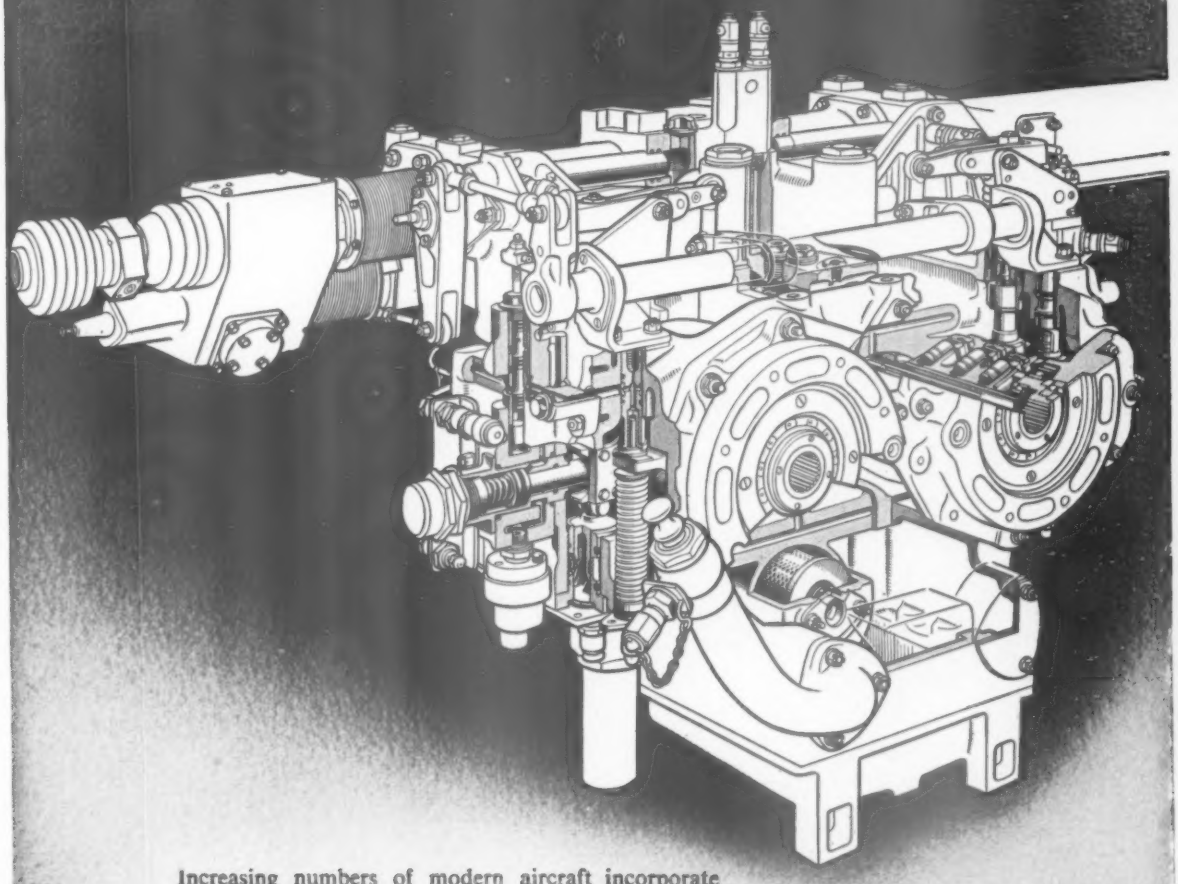

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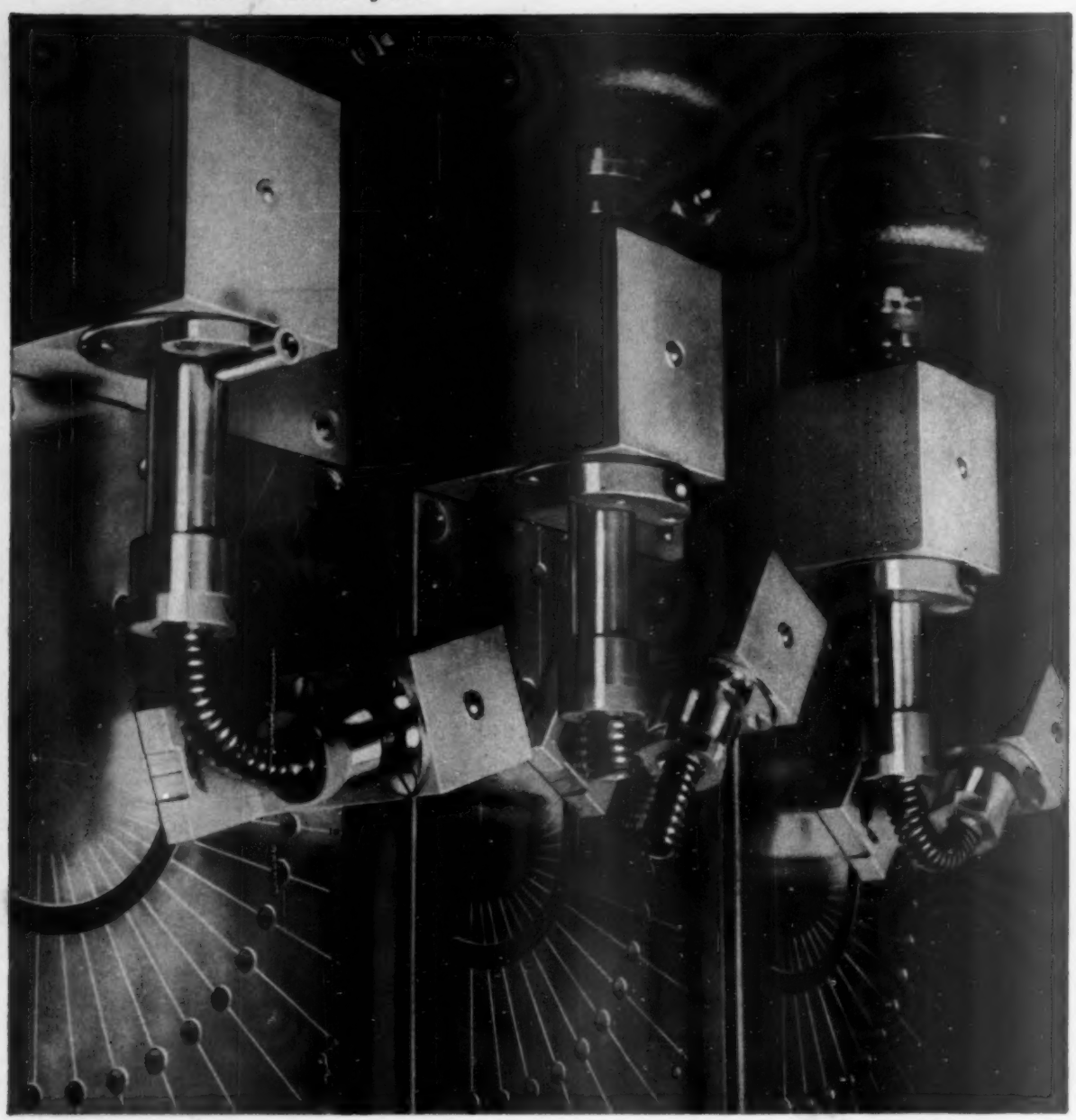

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